POWER PLANT ENGINEERING

CONTENTS FOR THE MONTH OF

FEBRUARY, 1940
VOLUME 44 NO. 2

Cover: Pickwick Landing Dam Power Plant. An interior view of the generator hall at the Tennessee Valley Authority's Power Plant at Pickwick Landing on the Tennessee River. The initial installation at this station consists of two 36,000 kw. units.

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Subscription price $2.00 a year in the United States, Possessions and Canada. Other countries $3.50 a year. Single copy current issue 25c; back issue 40c. Contents copyrighted.

PUBLISHED MONTHLY BY TECHNICAL PUBLISHING CO., INC.

KINGSLEY L. RICE, President
EDWIN C. PROUTY, Vice President
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PUBLICATION OFFICE, 53 W. JACKSON BLVD.
CHICAGO, ILLINOIS

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CHICAGO: Charles S. Clarke, 53 W. Jackson Blvd., Chicago, Ill.
PHILADELPHIA: H. G. Wilds, 118 Penarth Road, Bala Cynwyd, Pa.
NEW YORK: John A. Kershaw, Graybar Bldg., New York, N. Y.
CLEVELAND: George E. Andrews, 11733 Edgewater Dr., Lakewood, O.

GETTING INSIDE INFORMATION

IN 1895 WILHELM KONRAD ROENTGEN discovered a strange penetrating form of radiation which subsequently became known as X-rays because of their mysterious properties. The first X-ray tubes were delicate, fragile affairs, weak in structure and weak in their production of X-rays. As time went on and as the electrical art developed X-ray tubes also developed and with the rise of electronic technique progress in the design and construction and the use of X-ray tubes continued at an accelerated pace. Voltages increased from 200,000 to 500,000, 800,000 and even a million volts. At the same time the equipments used in X-ray work became more compact, until today such equipment as the one shown above, although weighing 4500 lb. and operating at 220,000 volts, is made portable. This particular equipment is designed for obtaining inside information about the structure of large steel parts such as are used in the Power Industry. The detection of internal flaws in heavy castings or structural welds is of the utmost importance in high pressure steam work and without the X-ray manufacturers would be working very much in the dark. This 4500 lb. portable X-ray camera is being used at the East Pittsburgh Works of Westinghouse in the examination of castings on production lines. Shockproof, completely self-contained, ready for work wherever there is a proper supply, it generates X-rays with penetrating quality sufficient to pass through 3 in. of solid steel. It may be wheeled along production lines by two men since it is mounted on a chassis with balloon tired wheels.

WITH THE EDITORS

Added Power Plant Service

IN CLEVELAND, Ohio, during the week of January 22, a heating and ventilating exposition was staged for the purpose of interesting people in the products of some three hundred leading manufacturers. With sub-zero temperatures prevailing in many parts of the country, the daily papers filled with stories of soldiers fighting and perishing by freezing in the Arctic regions of Finland where the temperature is reported to be 50 and more degrees below zero, Admiral Byrd and his expedition in the South Pole regions receiving frequent attention by the papers, the minds of all of us common mortals intent upon making our atmospheric conditions more comfortable—the time selected for this exposition seems most opportune, particularly to gain the attention of the general public.

To assist in supplying this comfort to the people of the country, the engineer is being called more and more into service. The power engineer took on this added field of service when he conceived the idea of saving fuel by the use of exhaust steam from his engine but he has found that the problem of air conditioning for human comfort does not stop with merely heating the air. The fastidious occupants of assembly halls, office buildings, hotels, hospitals, schools and industrial buildings demand, in addition to suitable temperature, a relative humidity that is conducive to health and comfort, the air must be free of earth and industrially produced dusts, even weed pollen must be removed to suit some people, injurious and odorous gases must be removed as well as air borne disease germs. So today the large majority of power plants have, as adjuncts or a major part of their equipment, machinery and apparatus that seem, so far as their service goes, far remote from that used for power generation—but they are not, as would be evident to any engineer who visited the exposition or examined a list of the equipment on display.

Combustion equipment, boilers, water heaters, piping, pumps, fans, insulation, refrigeration equipment, radiators are all familiar in design and operation to the power engineer. The specialist in heating and ventilating, however, has introduced refinements into the field, as a result of research, that make the service the more exacting one of maintaining healthful atmospheric conditions. Only a few years ago the phrase "it isn't the temperature, it's the humidity" became so common that people now demand a definite control of this quality of atmosphere. And with this demand came also means for washing and purifying the air, the growth of which has brought forth not only spraying and filtering methods but the more exacting electrolytic devices capable of clarifying air of such fine particles as cigarette smoke and ragweed pollen.

Inasmuch as heating has long been a power plant service, industrial establishments are turning to this department for the men to supervise their air conditioning systems. Furthermore, industries are learning that the success of certain processes depends so greatly upon atmospheric conditions that the field for this equipment is rapidly expanding. This transition is bringing under the power engineer's supervision many new types of instruments and control equipment, the operation and limitations of which he must understand thoroughly. In furthering information on air conditioning equipment the Sixth International Heating and Ventilating Exposition has been a service to those engineers fortunate enough to have attended but, more important than this, such expositions are helpful in acquainting the general public, those who are the recipients of the service, with what the industry can do for them, for it is only through the advancing desires of users that the service can be extended.

A Live Industry Needs Modern Experts

IN EVERY way one looks at the electric power industry he finds it active, growing and improving its product. One of the first to start climbing out of the depression valley, the privately owned utilities have shown an almost steady increase in load rising annually from 10 to 15 per cent.

Operating companies have been making profits, not in any great quantities but in sufficiently substantial amounts, even at reduced rates for power, to enable the financing of improvements and new projects by the sale of stocks and bonds on the stock exchanges of the country. And it is interesting to note that, amid a slackening of activity in a number of other industries, the electric utilities are adopting construction budgets for 1940 estimated at around $600,000,000, considerably in advance of expenditures in 1939 which are estimated at $450,000,000.

If we were to look at the financial picture alone, however, we would miss many of the extremely important activities of the industry that are contributing to its advancement. While the manufacturing industry was in the doldrums, extreme efforts were made to increase the domestic service load by extension of lines into rural districts and to adopt rate schedules that made the use of electrical appliances such as cooking ranges, water heaters, summer air conditioning equipment and refrigerators more economical to use than formerly. These policies have kept the utility load increasing at a rather regular rate even with a decreased industrial load. During recent years, however, the industrial load has been increasing so that each month the electrical load is breaking records.

To the power plant engineer, the increased construction made necessary by demands for more power service means that this live and going industry must have men at the controls in their plants who are trained by education and experience to handle the most sensitive as well as the most expensive machinery used in industry. To those men the expanding industry also means greater responsibilities and more exacting personal qualifications.

Design A of the W

HERE IS A PHOTOGRAPH of the Generator Room at the Winfield Hydroelectric Generating Station of the Kanawha Valley Power Co. which is described in the following pages. It is an unusual generator room, in fact it does not look like a generator room at all for there are no generators visible. Furthermore, the room appears strangely empty and deserted—there do not seem to be any operators around. Where are the generators and where are the operators?

As explained in the article on the following pages, there are no operators; Winfield is an entirely automatic station controlled by the changes in water level. As the water level in the forebay rises, the generating units are cut in in proper sequence and the load distributed among the units in accordance with a predetermined loading schedule. As to the apparent absence of generators, this effect has been produced by making the tops of the generators flush with the floor.

These features are only two of a number which make this station perhaps the most modern hydroelectric plant in the world. Built at a navigation dam built by the United States Government, it is a splendid example of cooperative effort between government and private enterprise for the most effective use of national resources. Because of high tail water levels at times of flood and because of the absence of firm output, this station would not have been possible except as a part of a large interconnected system.

On the electrical side, the use of pull-in type automatic synchronizers is of interest. With these equipments, the generators are synchronized without the application of field current. These synchronizers were installed as a consequence of certain difficulties experienced at Marmet and London, its two sister stations. With these synchronizers the machines are synchronized in 45 seconds as compared with a period of from one to five minutes formerly necessary at London and Marmet. Since these automatic synchronizers were installed at Winfield, similar units have been installed at London and Marmet to replace the manual system formerly used. Another feature of the electrical system is the carrier current system of supervisory control and telemetering. Although normally automatic in its operation, the station can be controlled from a distant control center by means of this carrier current system which does away with the necessity of all pilot wires.

Finally, must be mentioned the attention to detail for appearance sake. All the governors are of the enclosed cabinet type as are also the oil head control equipments. From a purely engineering standpoint there is perhaps no reason why they should be enclosed but it adds much to the streamlined appearance of the station.

And Operating Features Winfield Hydro Development

BY

PHILIP SPORN AND E. L. PETERSON
Vice President and Chief Engineer Transmission Engineer
American Gas and Electric Service Corporation

THE WINFIELD PLANT is the third of a series of three hydroelectric plants placed in operation within the last three years by the Kanawha Valley Power Co., a subsidiary of the American Gas and Electric Co. All three plants are located on the Kanawha River, a tributary of the Ohio River. Figure 1 shows the relative location of these plants. Winfield is located 31 miles above the mouth of the Kanawha River; Marmet is 37 miles upstream from Winfield; and London in turn 15 miles above Marmet. A description of the London and Marmet Plants has already been published.[1] This article, therefore will deal principally with the Winfield Development and with those features which are different or unique in Winfield as contrasted with the two previous developments.

As will be noted from Fig. 1, three tributaries, i.e., the Elk, Coal, and Pocatalico rivers drain into the Kanawha River between Marmet and Winfield, giving an appreciably greater flow at Winfield than at the other two plants. There is, however, a greater proportion of reduction of output at Winfield than at either Marmet or London due to its greater proximity to the Ohio River and the consequent tail-water rise caused by floods in that river, which floods are normally of longer duration than those of the Kanawha River. The duration of high tail-water is, moreover, increased due to the fact that the flood peaks of the Ohio and Kanawha rivers are generally not coincident. The effect of this on the quality of power available is shown clearly in Fig. 2 which shows the power duration curve for Winfield as compared with those for Marmet and London. In order to show the comparison of power duration more clearly, additional curves for the output of the latter two plants have been drawn which have been stepped up by a ratio of the installed capacity at Winfield to that of Marmet and London respectively.

[1]Power Plant Engineering, February 1937.

As at London and at Marmet the Winfield Plant was constructed at a navigation dam built by the United States. A license was obtained from the United States Government to operate the plant for a period of 50 yr., for a yearly license fee covering the use of water and dam facilities. The license stipulates that the prime consideration in the control of the forebay pool is that of navigation requirements with power production a secondary consideration.

Due to the above restriction, and particularly to the low quality of power availability due to tail-water elevation at times of increased river discharge, together with the absence of firm power output, the Winfield Plant, to an even greater extent than was the case with London and Marmet, would not have been feasible except as part of a large interconnected and integrated power system. The nearness of the site to existing transmission and distribution facilities of the Appalachian Electric Power Company overcame what might otherwise have been a fatal economic weakness of any similar hydro situation under isolated circumstances. In line with the above economic consideration, the principles adopted in the design of the plant were to reduce all the elements to the barest necessities consistent with safety and sound operation. Low operating cost was assured not only by simplification of design but by the provision of full automatic operation for the plant by means of float control.

General Layout

Figure 3 shows an aeroplane view of the power plant located on the westerly end of the navigation dam. The power house building is 157 ft. long by 55 ft. wide and houses three adjustable blade turbines spaced on 52 ft. centers. Projecting beyond the power house on the landward side can be seen the steel structure used for transporting and storing the stop-logs for the intakes. At London and Marmet provision had to be made for such structures to store

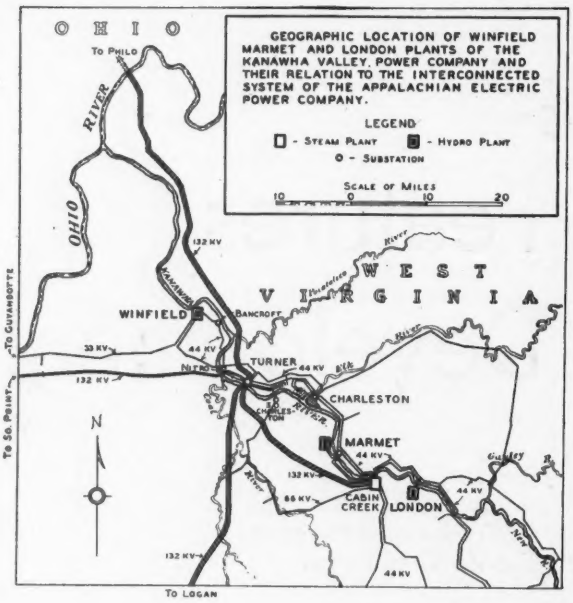


Fig. 1. Map showing the location of the Winfield plant with respect to the other plants of the Kanawha Valley Power Co.

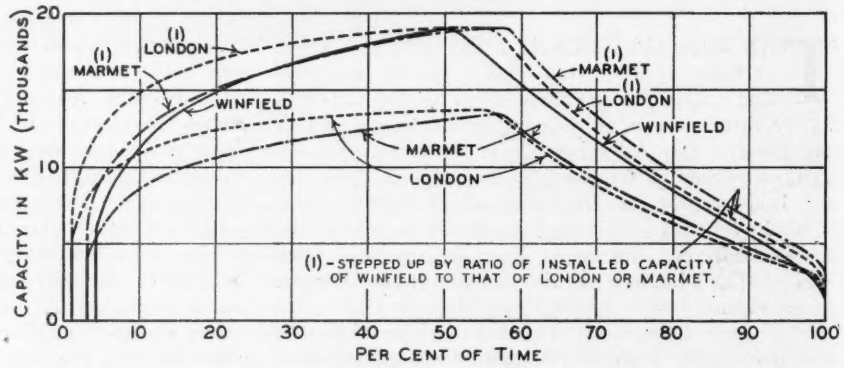


Fig. 2. Comparison of power distribution curves. Although there is a greater water flow at Winfield than at Marmet or London, the relative power duration is less

and clam shell buckets. Most of the excavate was hauled in trucks to a nearby depression located about a thousand feet from the power house site. As at London, a one cubic yard mixing plant was erected and the major portion of the concrete transported with derricks and bucket buggies, supplemented by a pumping system with a re-mixer.

Care was taken in the placement of the concrete to avoid segregation. Chutes were used only where absolutely necessary and the free drop in all cases was kept under five feet. Concrete was poured in alternate monoliths in horizontal layers not exceeding 18 inches in thickness and carried out as a continuous operation until the completion of a block or lift. As an aid to placement of concrete, mechanical internal vibrating equipment was used.

The concrete used at Winfield was of the same type as that used at London and Marmet. While the masses of concrete were not extremely large in volume, it was, nevertheless, felt desirable to limit the heat generation to a minimum. Among other things, resort was had to the use of a special cement which might be called moderate heat cement. The specifications limited the heat producing compounds of tricalcium silicate and tricalcium aluminate.

the emergency bulkheads used by the Government when work was to be performed on the roller gates of the dam. At Winfield, however, these bulkheads are stored on the lock side of the dam. The locks, as well as the lock operating house, are clearly indicated in Fig. 3. The same view also shows the outdoor switchyard located on the west bank just upstream from the power house, to which reference is made later.

Construction Plan and Materials

A general contract was entered into with the firm of Boso and Ritchie for the construction of the plant. Since the construction of the Winfield power house was carried out concurrently with the Government dam, use was made of its cellular cofferdams. The downstream arm of the cofferdam had to be extended landward, however, using similar cellular construction. At the landward side of the power plant, two sheet pile cells 50 ft. in diameter were erected to form the bulkhead together with a straight wall diaphragm extending landward from this cellular cofferdam so as to form a cut-off wall.

The general construction program was similar to that followed at London and Marmet. The power house area was excavated by means of power shovels

Hydraulic Plant and Equipment

The Winfield hydraulic installation is in general a duplicate of that at London and Marmet. Due to the increased head, the center line of the distributors was lowered 3 ft., making the maximum draft head 9 ft. instead of 12 ft. as at London and Marmet. Owing to the larger amount of variation in net operating head at Winfield, and to the larger wheel rating obtainable within a given setting for an adjustable as against a fixed unit, and the minimum power requirements called for under the license, at least two of the three turbines selected had to be of the adjustable blade type if they were to conform to the same dimensions as the units for London and Marmet. The decision to install three adjustable blade units was arrived at on the basis of the satisfactory performance with the adjustable blade units at both London and Marmet, and the increase both in capacity and kwh. output that those units showed over the fixed blade units of the same size. The plant thus has three adjustable blade turbines, two of the I. P. Morris Kaplan type and one of the Newport News automatically-adjustable blade type. The former have

a rated capacity of 9200 hp. under a net head of 26 ft. at a speed of 90 rpm. The diameter of their runners is 169 in. The automatically-adjustable blade propeller turbine, in which there is no interconnection between the runner vanes and the governor has a rated capacity of 9150 hp. under the 26-ft. head and 90 rpm. The diameter of the runner of this unit is 177 in. The principal change in the Kaplan turbines from those installed at London and Marmet was in the speed rings. These were integrally cast in three sections instead of having independent stay vanes. The difficulty of proper and quick erection of the latter type of design at London and Marmet definitely demonstrated the economy and desirability of integral construction. A change in the automatically-adjustable turbine installation was the substitution of rubber lined guide bearings for the lignum-vitæ bearings used at London and Marmet.

At London and Marmet sharp sand, which the strainers in the water supply intakes could not entirely remove, caused considerable wear on both the lignum-vitæ and rubber bearings. Subsequently, filter machines of the revolving cylinder type were installed. At Winfield a similar filter installation was made which, in addition to filtering water for the bearings, also, as at London and Marmet, filters the water for the generator cooling systems. These filters are self-cleaning, and their use eliminates the necessary shut-down in case of sudden clogging of the strainers and consequent stoppage of the water supply where dependence is placed on duplicate strainers alone.

Electric Plant

Three identical generators are installed at Winfield. They are essentially the same as those at London and Marmet but have 150 kva. higher rating. They have a nominal rating of 6150 kva.; 90 rpm.; 80 pole; 3 phase; 60 cycle; 4150 v. As will be noted from Fig. 4, showing a cross-section of the plant, the top of the housing is flush with the generator floor thus reducing somewhat the height of the superstructure and adding a pleasing appearance to the interior. A further reduction in building height was obtained by using an almost flat roof slope and roof trusses of minimum depth.

DESIGN, CONSTRUCTION AND EQUIPMENT DATA

Engineers and Supervisors—American Gas and Electric Service Corporation.
Consulting Engineer—F. W. Scheidenhelm.
Consulting Architect—Eddy Fairchild.
General Contractors—Boso and Ritchie.
Hydraulic Turbines—Baldwin-Southwark Corp. (I. P. Morris Div.) (2); Newport News Shipbuilding & Dry Dock Co. (1).
Governors—Woodward Governor Company.
Alternators—General Electric Company.
Exciters—Westinghouse Electric & Manufacturing Co.
Transformers and Circuit Breakers—General Electric Company; Westinghouse Electric & Manufacturing Co.
Auxiliary Dist. Equipment—I.T.E. Circuit Breaker Company.
Automatic Switching Equip. Supervisory and Telemetering Equipment—Westinghouse Electric & Manufacturing Co.
Fire Protection—C-O Two Fire Equipment Company.
Structural Steel—Virginia Bridge and Iron Company.
Head Gates, Stop Logs, and Trash Racks—Virginia Bridge and Iron Company.
Cranes—Philips & Davies, Inc.
Roof Slabs—Federal-American Cement Tile Company.
Roofing—General Roofing & Air Conditioning Corp.
Cement—Diamond Portland Cement Company; Green Bag Cement Company of West Virginia; Penn-Dixie Cement Corporation.
Hydraulic Lime—Riverton Lime Company.
Winter-Kennedy Piezometers—Simplex Valve and Meter Company.

The electric layout of the plant, as may be noted from the simplified diagram, Fig. 5, employes a single bus. Each generator is switched by a single, modified type, low tension breaker. Three single-phase, three-winding transformers are used to supply 33 kv. to the Guyandotte line and 44 kv. to two lines to Turner. By referring to Fig. 1, it will be noted that these lines tie the plant into the interconnected system of the Appalachian Electric Power Co. The Guyandotte line and one of the Turner lines are double circuit for a distance of six miles out of Winfield. The circuits are strung on double-circuit, semi-flexible, steel towers

Fig. 3. An airplane view of the Winfield Development showing the government owned dam and navigation locks and the privately owned power plant switchyard and outgoing transmission lines. The power plant houses three adjustable blade turbines of approximate 9200 hp. capacity, each. Two of these are Kaplan units while the third is of the automatically adjustable blade type

to a point on a previously existing steel tower line extending from Turner to Guyandotte. At this point the Turner-Guyandotte line was opened and connections made to the new circuits to Winfield. Another 44 kv. connection to Turner was obtained by constructing a line to the existing substation at Bancroft, which was already served by a 44,000 v. line running out of Turner. Figure 6 shows a view of one of the double-circuit towers near Winfield. Fig. 7 is a view of the automatic combination 33,000 v. and 44,000 v. switchyard at Winfield showing transformers, breakers, protective equipment, and outgoing lines.

Governors

The London and Marmet Plants utilized one of the first installations of the Woodward cabinet type governors, wherein the actuator, pumping unit, piping,

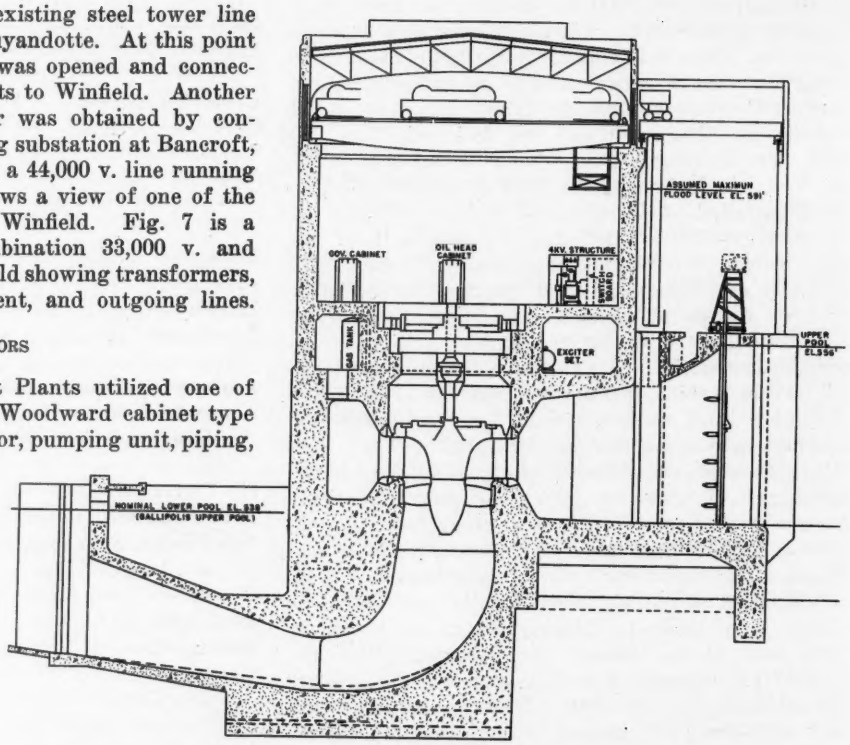


Fig. 4. Cross section through the power plant showing one of the Kaplan units. The generator tops are flush with the generator room floor which also carries the governor cabinets and low tension switchboard

and restoring mechanism is compacted and enclosed in a single cabinet. Similar governors were used at Winfield. The Winfield governors, however, due to experience gained at Marmet and London were constructed with slight modifications to the ball heads and to the oil inlet valves. Changes were made also in the type of oil pressure failure relays and refinements in maintaining and controlling the governor oil pressure. While the cabinet type governor does not incorporate any radical departures from old governing practice, nevertheless, the reduction in space required and the attractive appearance of the cabinet gives the cabinet type actuator many advantages. Furthermore, the gages and control mechanisms are mounted on the cabinet for ready operation and supervision.

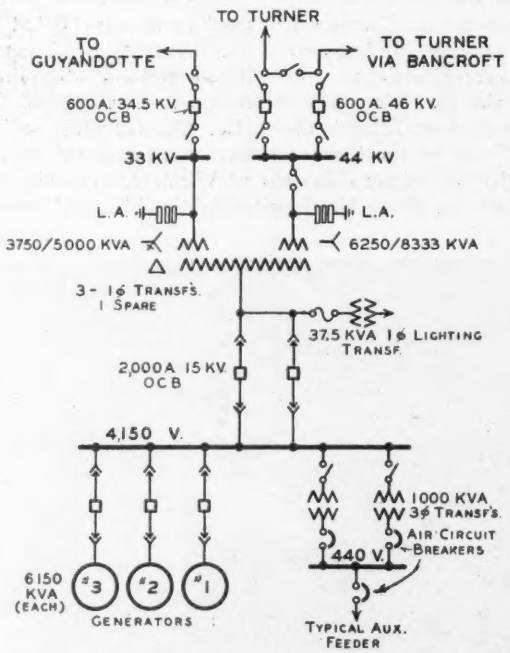


Fig. 5. Simplified diagram showing the electrical layout of the plant. Three single phase transformers are used to supply one 33 kv. and two 44 kv. outgoing lines

Architecture and Arrangement

The same functional principles followed in the building design and arrangement of London and Marmet were adhered to in Winfield. Volume here was even further reduced than in the previous two plants. Reference has already been made to the shortening of the turbine shaft and to the depressing of the top of the generator housing to the level of the top of the floor. Further study showed that the resulting clearing up of the generator floor would make possible, with only a slight widening of the building, the location of switching and switchboard equipment on the generator floor and the entire elimination of the balcony which supported this equipment at London and Marmet. This was done and it resulted in an outstandingly clean and modern looking generator room. It has the advantage too of bringing on one floor all the governing, switching, and switchboard equipment. The reduction in building which this made possible in turn made possible the improvement in front and side elevations of the plant shown in Fig. 8. Attention is directed also to the sparing but effective use made of glass brick in this plant and to the harmonious blending of steel, glass, and concrete.

Special Features

(a) Automatic Control

Several changes from and additions to the automatic control employed at Marmet and London were made in the controls for the Winfield Plant. One of the features which has greatly simplified the control and has speeded up the operation of putting the generators on the line has been the use of the pull-in type of synchronizing in which the machines are brought into synchronism without the application of any field. Experience at Marmet and London showed that for units of this type actual synchronizing in the normal manner was a somewhat difficult process which caused a considerable delay at times in getting the units connected to the system. The generators, therefore, were bought with specially braced windings to permit pull-in synchronization. Thus far this scheme of operation has proved much more satisfactory than the former method of synchronizing employed, since the time required to bring a unit into synchronism at Winfield is about 45 sec. as against one to five minutes or more at London and Marmet.

(b) Float Control

Of special interest also at Winfield is the fact that the plant is operated by means of float control. This float control is unique in the fact that three large units are controlled by a change in water level of only four inches. The starting, stopping, and loading operations for the machines are accomplished by operating the gate limit control of the governors by means of a float device. This device consists essentially of a Selsyn transmitter attached to the head-water float and three Selsyn receivers, one for each governor, so arranged as to operate the gate limit device on the governor. The result is that the gate limit device assumes a position at all times corresponding to the position of the float and hence to the head-water elevation.

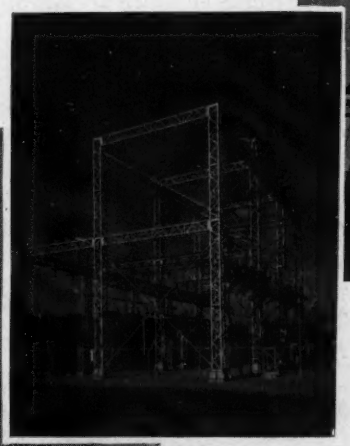
The actual starting and stopping of the units is accomplished by means of contacts attached to the gate limit device of each governor, fixed to correspond to a predetermined head-water elevation. Under a hypothetical example of operation and setting, let us assume that all units are shut down. Rising head-water will start one selected unit, put it on the line, and load it at approximately 50 per cent gate opening. If the pond level continues to rise, the first unit will continue to load up until reaching approximately 70 per cent gate, at which point a second selected unit will be started, put on the line, and loaded up to approximately 70 per cent gate. If the pond elevation remains constant, these two units will operate at 70 per cent gate. If the elevation decreases, the units will unload correspondingly until at a pre-selected setting, the second unit will be taken off the line.

The starting of the third unit is accomplished in a similar manner to that for the second unit, except that the first two units will have been loaded to approximately 80 per cent gate before the contacts close to bring on the third unit. If the pond level continues to rise, all three units will load to the full open gate position. As the head-water level decreases, the No. 3 and No. 2 units will go off in a manner similar to that previously described for No. 2 unit. If the level continues to decrease, the No. 1 unit will shut down at approximately 15 per cent load. In order to avoid too frequent shutting down and placing of units in operation due to possible intermittent fluctuation of the water level, a time delay is interposed in the sequence of operation.

Experience with this float control has been very satisfactory, in fact, so much so that the Marmet Plant was later equipped with the same type of control. Experience has also shown, however, that in order to gain the maximum output of the units under all heads that some change in the float control limits should be made automatically for various head levels.

Fig. 6. (Below)—Two of the 44 kv. circuits from Winfield are carried on steel towers

Fig. 7. (Center)—Automatic 33 and 44 kv. switching yards. The auxiliary transformers are also outdoors



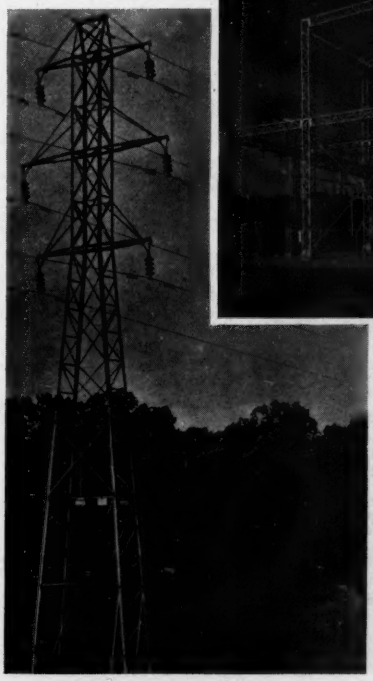


Fig. 8. (Upper Right)—Exterior of the plant. The design harmonizes with other dam structures

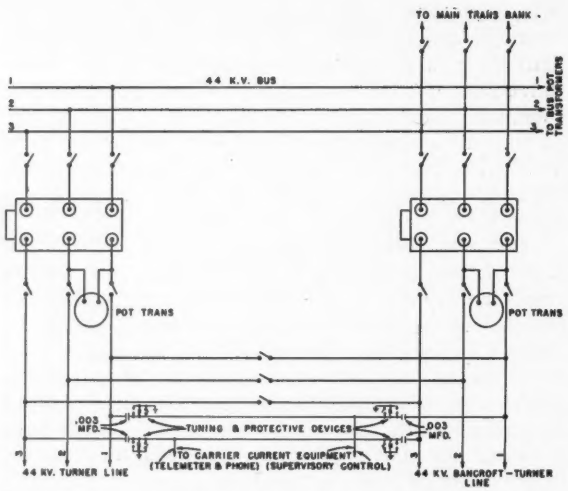


Fig. 9. Carrier current telemetering and communication channels are connected to phase 3 and carrier current supervising to phase 1 on both of the 44 kv. lines between Winfield and the central dispatching point at Turner

This is due to the fact that the units are somewhat overgated at normal head and consequently to limit the load on the machines at normal head and heads slightly higher than normal, it is necessary to set a certain limit on the governors. As the head decreases, however, due to high tail-water, it is not economical to limit the units in output. An arrangement is now being worked out whereby a change in the net head will automatically change the loading limit of the units so that at all heads it may still be possible to secure maximum output without danger of overloading.

(c) Carrier Current Supervisory Control

As at Marmet and London, the control of the Winfield Plant can be taken over by the remote supervisory control system. This allows full control of the plant from the central dispatching point without the necessity of having operators on duty in the plant. A new type of supervisory control, however, was utilized at Winfield. At London and Marmet the supervisory equipment was made inoperative several times due to malicious destruction of the supervisory pilot control cable by thoughtless or irresponsible persons with guns. At Winfield it was, therefore, decided to make use of a carrier current type of supervisory connection between the dispatching and control points. Since it was necessary to provide for not only supervisory control but also for a considerable number of telemetering indications, it was decided to install two carrier channels, one for control and one for metering. Each channel is connected to a phase of both 44 kv. lines extending between Winfield and its dispatching point, Turner Substation. Complete operation may then be secured with both lines out and even with sections of either line grounded. Fig. 9 shows a simplified wiring arrangement used in connecting the capacitors and traps to the two lines used to transmit the two carrier channels.

(d) Automatic Operation

In so far as operation is concerned, this plant is classified and is actually operated as an automatic station. No operating personnel is maintained at the plant at any time. (Enough routine maintenance is carried out to call, however, for the regular services of one maintenance man working a 40-hr. week shift.) Instead, the switchboard stands as a silent but efficient control and watch center, maintaining at all times accurate, constant, and correct control over the various generators and high voltage lines. Figure 10 is a photograph showing the entire switchboard for the Winfield installation. The four panels on the extreme left represent the supervisory control and telemetering devices. The battery panel is next in line, followed by nine panels on which are mounted all of the control devices necessary for the complete protection, starting and stopping, and supervision of the three generators. The seven panels on the extreme right, are used for the control of the three high voltage line breakers, the transformer bank, and various auxiliary equipment.

(e) Newport News Adjustable Unit

The installation of an automatically-adjustable blade runner of the non-Kaplan type on one of the

Continued on Page 46

Fig. 10. Switchboard containing control, protective and supervisory devices and telemetering equipment. So far as operation is concerned the Winfield plant is actually an automatic station. No operating personnel is maintained at the plant at any time. The switchboard stands as a silent, efficient control and watch center maintaining strict and accurate control over the station at all times

Management and the Worker

OBJECTS of a Management Board are to increase returns to the business,—workers, executives and investors. Obviously this is to be accomplished by increasing gross income and reducing expenses. The first can come from increasing output and sales or from higher prices, but prices are usually limited by competition and by what customers will pay. To increase output beyond what can be sold results only in frozen assets; hence the importance which always attaches to effective sales organization and methods and to the market which can be created by satisfactory public relations. It is of first importance that the Board keep this in mind, as, in order to benefit the members of the organization, public good will to buy the company's product must be secured and maintained. But, to do this, as has been emphasized, a prime requisite is good will of workers in the organization and a reputation for fair dealing in *all* transactions.

Internal matters with which the board will be concerned are security of jobs, wages, working conditions, production methods, costs, selling and overhead expenses. External matters will cover selling methods, sales force, customers' acceptance of product, relation of sales volume to price, reputation of the company and its product.

Output, Prices and Wages

Multitudes of wage payment plans have been devised and tried in the effort to better the income of workers and give extra reward for better output. The Board must consider what method will best meet conditions in the organization to provide adequate compensation for work done, satisfy workers and keep costs at a level which will ensure the widest market for the product. For only in a wide market lies the opportunity for increased income and job security. It is part of the function of the Board to inform all in the organization of the relation of factors such as costs of material, labor, management, equipment, to price; and the relation of price to market and income. Workers should understand their part in the success of the enterprise and, barring outside influence, will be in position to coöperate intelligently in working for the company's success. Above all, it should be made clear that economic welfare of any nation or organization depends upon output produced by work and on a profitable cost of production. Workers of all classes should be considered as citizens of an industrial community whose welfare is bound up with that of the community.

Plant Conditions

Working conditions, including safety, comfort and speed of working, can be a major cause of dissension, which will nullify the good effects of high wages and short hours. It is essential, therefore, that the Board establish an effective system for considering and acting promptly on all suggestions and complaints about working conditions. Workers and their representatives should have opportunity for presenting their case and for fullest discussion. It may be good policy to have free discussion at a meeting of workers so that they may have a clear understanding of what is desired before the questions are considered by the Board. Any difficulties in meeting these desires can then be considered and decision reached as to the best method of handling the matter. If the decision is unfavorable, reasons should be made clear to all workers and, when possible, some alternative proposed. Unless dissatisfaction with working conditions, even in minor matters, is given prompt attention, it may grow to be a major cause of discord in the organization.

Safety precautions and rules may well be handled by a workers' committee, reporting to the Board, but it is essential that some executives be designated to work on or with this committee in order to animate the observance of such rules and precautions and emphasize their importance to workers. The same committee may be the best means of insuring proper lighting, heating and ventilation, sanitation and other factos affecting the comfort of workers.

In this connection, the relation of these comfort factors to output and income should be made clear, also the effect of malingering and restriction of output on income and return to all workers in the organization.

Production and selling methods must, as a rule, be worked out by executives, although suggestions by workers and salesmen are frequently found most effective. Reasons for adopting the methods in use should, however, be clearly understood by all in the organization, in order that suggestions for improvement may be made with full understanding.

In the work of a management board it is vital that workers' representatives be really representative, not the spokesmen of minorities in any department. Minorities have a right to present their point of view but, in an industrial democracy, the majority should have the responsibility, endeavoring always to meet the views of the minority as far as possible. Hence, representatives should be freely chosen, should understand that they represent all workers, and that the object of management is to give a fair deal to workers, management, investors and customers.

Reports to Organization Members

In its reports to workers, the management board should embody information that workers want about company finances, policies and methods in order to give a clear understanding of why its decisions are reached. In one survey, workers expressed a desire for data on the amounts of income from yearly business; profits; dividends; surplus additions; executives' salaries; output, income and profits for each department. These are fundamentals in understanding the financial condition of a company but, in giving these, the expense for materials, labor, supervi-

sion, overhead should be shown, preferably by departments as well as in total, so that workers may understand the items which cause the difference between income and profits. Also the relation of volume of business to profits, since supervision, overhead and selling cost will always be a part of the expense which will not increase as rapidly as income from greater business. Cost per man-hour, production per man-hour and the consequent cost per unit of product should be made clear as a main factor in selling price, hence a main factor in volume of sales and yearly income. This does not imply a low cost per man-hour. The success of American industry and the high standard of living in the United States are based on a high wage rate and high production per man-hour. The aim of management should be to raise the cost per man-hour by higher wage rate, improved machinery and larger use of power, so long as production per man-hour is increased thereby and cost per unit of product is reduced.

Wages and job security will always be major interests of all men. Hence the factors which bear on these two items should be made clear, also the basis on which promotions, wage increases and retention of workers in dull times, so that all workers may realize how they can better their positions.

One form of yearly financial report which has received favorable comment is as shown herewith.

YEARLY REPORT TO ORGANIZATION MEMBERS

Income:		
1. Billed to customers for product sold	$22,360,832	
2. Deduct for uncollectable accounts	14,648	
3. Leaves net return from sales	22,346,184	
4. Dividends received from investments	3,794	
5. Interest, rent and other income	111,833	%
6. Total income	$22,461,811	—100
Paid out:		
7. Materials, fuel, supplies, transportation	$11,898,107	— 53
8. Reserve set aside for wear and replacement	1,132,988	— 5
9. Interest on borrowed money and rent	240,837	— 1.1
10. Taxes	673,594	— 3
	$13,945,526	
11. Leaves for workers, management and investors	8,516,285	— 37.9
	$22,461,811	—100
Amount distributetd was:	Amt.	
12. To executives and management	$ 512,471	— 6
13. To workers who sold the product	2,989,414	— 35
14. To workers who manufactured and serviced product	5,039,297	— 59
15. Total distributed	$ 8,541,182	—100
16. To stockholders	Nothing	
17. Loss for the year	24,897	

WHAT MORE THAN WAGES?

As to what may best be done in what is termed "Welfare Work," this will be determined by size of the organization and local conditions. Group insurance, financial aid in emergencies, care and medical attendance in case of accidents are usual and appreciated by workers, and may well be handled by the management board or, if workers contribute to funds for such activities, by a special committee representing workers and management reporting to the management board.

Other activities such as educational, social and athletic facilities may be given support by the company, especially in small communities where they would otherwise not be available. They should be only those desired and used by a considerable percentage of workers and should be managed by workers' committees under such regulations as the board may establish. Workers often resent anything smacking of paternalism and prefer that any available funds be distributed as wages, hence it is generally desirable that such activities be placed on a self-supporting basis by means of dues and admission fees so far as operating expense is concerned, but the company may find it desirable to take care of any managerial and clerical expense.

As a summary of desirable objects of the management board, Milton Wright in his book on Public Relations for Business gives the following:

Give workers assurance of permanent employment, see that they are employed steadily at fair wages that compare favorably with what others are paid for similar work. Provide incentives for good work.

Establish means for meeting workers and their representatives for joint discussion of plant problems, complaints and suggestions and explain clearly the reasons for all decisions.

Keep workers informed, in understandable terms, of the company's activities and results.

Promote the health, comfort and general well being of workers and their families both inside and outside the plant.

Identify the workers' interests with those of the company.

Be human in all relations with workers.

Smoke Bureau Operates at a Profit

ACCORDING to Frank A. Chambers, City of Chicago Deputy Smoke Inspector, the Smoke Department shows a profit for the second year. Total receipts from boiler permits and inspection fees during 1939 are estimated at $111,300 or $11,598 more than spent on salaries and supplies. The department had a $13,148 profit in 1938. In previous years it had an annual loss and the deficit was made up from the city operating fund. In 1938 the bureau started enforcing a new law requiring the annual inspection of heating and power plants in all buildings except one and two family dwellings, with an inspection fee attached. During the present year, 43,188 furnaces have been inspected, compared to 37,815 last year. The department, which also inspects heating systems where excess smoke is pouring from stacks, observed and investigated 303,168 such stacks, compared to 258,867 the previous year.

Electroforming with Iron

MOLDS and dies are now being prepared by a new process developed by the United States Rubber Co. which goes under the trade name of "EKKO," phonetic spelling of echo. The process is similar in many respects to electroplating as used by photoengravers but uses iron instead of copper or nickel and deposits the iron in thicknesses up to ½ inch. Electroforming is used to build up a mass of metal into a mold or die from a pattern it is wished to reproduce. This process offers advantages to almost any industry using molds or dies.

Dividends from Smoke Abatement

Modernization of combustion equipment in furniture factory cured smoke evil and reduced coal bill.

By
JOHN DONALY

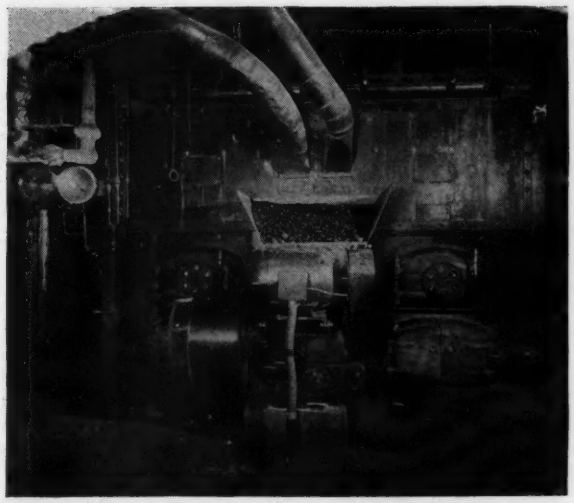


Fig. 1. Furnace in woodworking plant burns wood refuse and coal under a 250 hp. water tube boiler

AS ANTI-SMOKE regulations have been tightened throughout the country, most manufacturers—and particularly furniture manufacturers—have faced the unpleasant dilemma of (a) undertaking an expensive and sometimes time-wasting plant modernization plan or (b) closing up shop completely in addition to paying heavy fines.

Because furniture manufacturers face a power and heating problem met by few others, their troubles are unique. In any furniture plant, there is a large amount of refuse left after manufacturing processes have been completed on raw lumber; and it is obvious that efficient operation calls, not for the generous distribution of this refuse to the deserving poor, but for burning it in the company boilers.

Consumption of wood and coal, however, results in the supposedly inevitable emission of large quantities of smoke from the plant stack—so large an amount, in fact, that in most cities the consumption is in blatant violation of all the rules ever promulgated by the anti-smoke commissions. What to do thus becomes a very pretty problem for the furniture manufacturers.

Back in 1937, a South Bend, Ind., factory was not unusual. It had a large amount of wood processing to do, and the wood refuse was fed to the boilers on top of the coal fires. So much smoke resulted from this operation that, following the establishment of the South Bend anti-smoke ordinances, residents in the neighborhood of the factory filed rather bitter complaints with the city building commissioner, who, when reporting his findings to the city council, declared that the company realized its plant was creating a smoke nuisance and that, after some experiments with smoke consumers, it had ordered an underfeed stoker.

This decision to purchase an underfeed stoker had been made largely on the strength of a recommendation by two different woodworking companies, both of Rockford, Illinois. Each of these plants had been using underfeed stokers for firing the power boilers, and each of them had solved the same problem that now presented itself to the South Bend company—stoker-firing of coal in conjunction with hand-firing or automatic firing of wood refuse.

The average stoker is not equipped to shut off the coal feed if extra combustible material is thrown on the fire by hand or by any other means. The three furniture companies had to locate a stoker that possessed an unusual control—a control that would automatically shut off the fuel feed when the fire bed depth reached a certain level, regardless of whether that depth was obtained by hand-firing, stoker-firing, or a combination of the two.

The Rockford plants had found the correct stoker first, and each plant had installed two of the machines. The stokers were controlled by a device that relied for its actuation on the forced draft back pressure built up by the fuel bed depth in the retort. As the fuel bed depth increased, the back pressure of the air in the wind box surrounding the retort increased; this back pressure was communicated through a small copper tube to a delicate bellows; as the increasing air pressure collapsed the bellows, a tiny switch above the bellows cut off the coal feed. This permitted the fire to burn down until the air pressure "relaxed," the bellows opened up, and the switch closed, again starting the coal feed. Since the bellows was sensitive to as small as a 1 per cent change in the draft pressure from the wind box about the stoker retort, the fuel bed depth always was maintained at the correct level for most efficient combustion, regardless of any extraneous objects tossed on the fire by hand.

The use of the two stokers at one plant, under 150-hp. boilers, had effected cash savings of some 15 per cent. A cheaper grade of coal could be consumed by the stokers, a somewhat smaller tonnage was consumed, and the wages of a night watchman were eliminated. Thanks to the accurate control of the fire consistently held by the two stokers, the night fireman could combine his duties with those of the watchman. Besides all of this, firing had been simplified in two ways: it no longer was necessary to feed the furnace by hand-operated shovels, and wood refuse

Fig. 2. Automatic underfeed stokers supply coal supplemented by wood refuse as fuel for these 150 hp. water tube boilers

could now be spilled into the fire by the use of a gravity feed system on top of the boilers.

At the other Rockford plant, even more marked savings had been recorded. There, two 1200-lb. stokers, each generating approximately 300 hp., had been installed under two water tube boilers. Here it was found that the stokers served the dual purpose of eliminating the smoke nuisance and making a very appreciable slash in the power plant costs. The retail price of the stokers was $3500; yet the machines saved the company enough in fuel costs to pay for themselves in the first 15 months of operation—a clear saving of some $175 to $200 per month. In addition, of course, was the usual saving in man power—plus more efficient firing and a more uniform maintenance of steam pressure.

These facts so convinced the officials of the South Bend plant that they discarded the idea of smoke consumers in favor of the more expensive underfeed, screwfeed stoker with its automatic combustion control. The plant had two boilers—a 150-hp. unit and a 250-hp. water tube boiler. By stokering the larger of the two units, it was found possible to use the 150-hp. boiler as a reserve only. The stoker that finally went into the big boiler was a machine capable of burning 1600 lb. of coal an hour and of producing about 400 hp. The feeding rate, set at 1800 lb. an hour, assured quick pick-up when pick-up was necessary.

The stoker was bought for $2000. Before this expenditure was made, the plant had been burning about 25 carloads (sometimes 28 carloads) of egg coal annually, at a cost of some $3.30 per ton. Once the stoker had gone in, coal consumption was cut to 14 or 15 carloads a year, and this fuel (1½ in. dedusted screenings) cost the company only $3.08 a ton, on an average. Exact comparative figures are not available, but the most conservative estimate indicates that cash savings on fuel alone have amounted to at least $577.50, and as high as $750, per year. The stoker is easily paying for itself, without considering any savings other than those represented by reduced fuel costs.

The South Bend plant ordinarily operates 10¼ to 24 hr. a day; the shorter period in the summer. Two or three months of each year, nothing but coal is burned, although a cyclone separator was installed on top of the stoker-fired boiler for automatically feeding wood refuse to the fire. This separator, however, was used only for a short time; at present, shavings and other refuse are thrown on the fire by hand.

Design and Operating Features of the Winfield Hydro Development

Continued from Page 42.

units at Marmet aroused a great deal of interest since this was the first installation of its kind. On this unit there is no interconnection provided between the runner vanes and the governor. The four vanes are freely pivoted and so arranged that water impinging on the vanes sets up a moment, tending to increase the pitch of the vanes. This tendency to open is, however, balanced by a reactive device located in the hub and shaft which is urged downward by the differential in pressure between head-water and draft tube. As load changes occur, the runner vanes simultaneously assume a new angular position so that they are always set for the most efficient position for the particular condition of load and head.

The Marmet installation of this runner was to a certain extent of an experimental nature since only model sizes had previously been tested. The operation of the Marmet runner, however, fulfilled all design expectations, and it was decided therefore to install a similar runner at Winfield. At the same time an identical runner was ordered for the London Plant to supplant a Newport News fixed blade runner. This change was justified on the basis of the increased capacity and output which the adjustable runner made possible. The Winfield automatically-adjustable runner is identical to the Marmet runner except for minor refinements in detail.

(f) Summary

Winfield, it is believed, and it is hoped this brief description brings out, embodies not only all of the new ideas successfully worked out at London and Marmet but also a considerable number of innovations and improvements. Some of these had a material effect on further cost reduction; others merely gave more convenient or pleasing arrangements without appreciable savings. The primary aim, however, was again to obtain the most economical arrangement of equipment and facilities consistent with safety, and to not be bound even by the comparatively recent work at London and Marmet, in spite of the great similarity Winfield has to those two developments. This was the guiding criterion in the work of design and construction. The entirely satisfactory performance of the plant and its equipment is testimony of its soundness.

Condenser tube life is affected by many factors generally of a chemical, electrochemical or mechanical nature. The author reviewed for the A.S.M.E. many features of design and operation which, while entirely mechanical, have proved to be of great importance in affecting tube life. Only the more common points are covered in this abstract. When mechanical alterations prove costly or impractical, tube troubles can often be minimized or eliminated by a change in tube alloy.

Mechanical Factors Affecting Condenser Tube Life

BY A. J. GERMAN
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FROM EXPERIENCE it is known that air in the condenser circulating-water system is detrimental. Tubes carrying an unbroken column of water will last longer than if that column is intermittent. Many theories covering this question are available, but with admission that air in circulating water is damaging, we need not consider the theoretical aspects.

For the sake of brevity the terms turbulence and cavitation as used here imply the presence of damaging air bubbles in the circulating water. The damage brought about by this type of corrosion is usually found at inlet ends of the first-pass tubes, with very little or no evidence of such action at the inlet ends of the second-pass tubes. In unusual cases, the occurrence may be reversed.

Generally, trouble will be concentrated in specific zones of the condenser. Such localization of tube deterioration necessarily directs one's attention to the surrounding conditions and brings under consideration the related elements of the installation as the intake screen, suction bell, circulating pump, pump stuffing boxes, valves, piping, inlet and discharge piping, water boxes, ferrules, and the conditions affecting and effected by them. Such effects are in most cases traceable to factors far ahead of the tubes themselves. The correction must be at the source. An inspection to discover the causes of tube corrosion should cover the entire hydraulic cycle, starting at the intake canal.

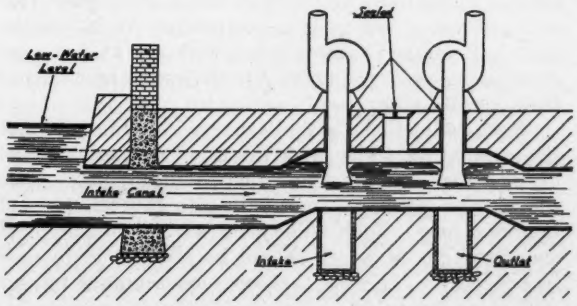


Fig. 1. Air was found to enter the suction bell of the pump with this arrangement even though the roof of the intake canal is lower than the roof of the intake tunnel

Design and Operation

Air in the circulating water may be of two types: (a) Air entrained mechanically, and (b) air released from solution by turbulence at low-pressure areas.

The bell at the end of the pump suction pipe may not be submerged sufficiently, particularly at low water. Such a condition obviously may permit great quantities of free air to enter. Air so introduced cannot be absorbed by the water, which is already saturated, and being carried along with the stream will damage tubes.

If the suction bell cannot be lowered, due to distance limitations between the bottom of the pipe and the floor of the intake canal, one or two branches may be run from the suction pipe to act as a secondary suction. This procedure will reduce the flow at the original suction bell and prevent an external cone from forming around it.

Free air has been found to enter at the suction bell even though the roof of the intake canal is lower than low-tide level. Figure 1 illustrates a case where such a condition was found. A new intake canal crossing over existing intake and discharge canals had been designed. Since all canals would still be below low-tide level, no objection was foreseen.

Until there was an especially high tide, which flooded the basement floor because of water entering around the suction pipe of the pump and manhole under the basement floor, no trouble developed. In

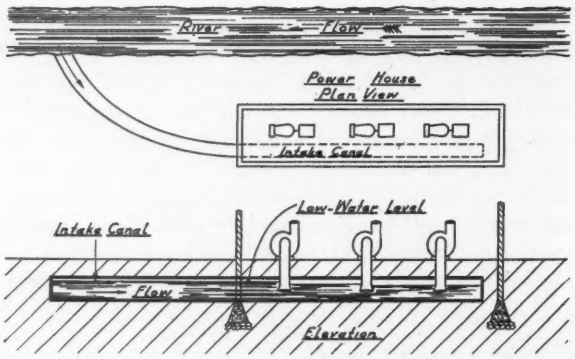


Fig. 2. When the water is low and three pumps are operating air may be sucked into the pumps even with this arrangement

order to prevent any further flooding, the openings at the top of the new intake canal were sealed with the result that air accumulated.

At quite regular intervals this air accumulation reached a point in the canal where a cone formed around the suction bell and the air discharged into the circulating-water system. The remedy, of course, was to vent the canal with a pipe, the top of which was a few feet higher than the extreme high-tide level. Tube life was thereby materially improved.

When a power plant is designed with a basement floor level dangerously close to conventional high tide, the designing of the intake canal calls for extra caution. Many plants have a number of pumps which obtain their water from one canal. Figure 2 illustrates a bad condition, as concerns tubes, resulting from such a layout.

When the canal was originally built, future additional capacity requirements were considered, but the additional units later installed proved to require a greater capacity than was originally contemplated. The factor of safety on canal size was insufficient. After plant expansion, with low water, capacity load, and all three units on the line, the water level in the canal dropped after each suction pipe, so that air was admitted into the suction pipe farthest away from the main intake end of the canal. The remedy in such a case, when possible, is to extend the canal from the terminal end to the source of supply.

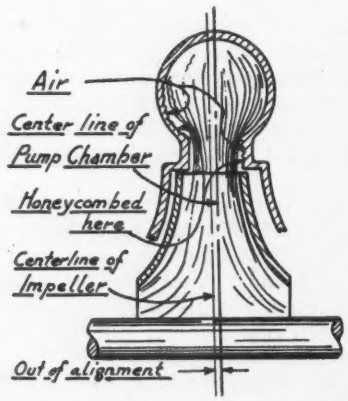


Fig. 3. Misalignment of pump impeller will increase turbulence and may cause cavitation

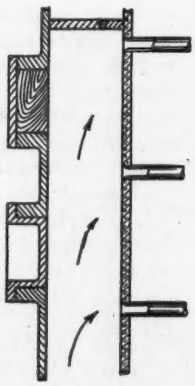


Fig. 4. Inspection doors arranged to eliminate water box turbulence

A second source of entrained air in the circulating water is found in circulating-pump stuffing boxes, water-sealed with the seal connected to the discharge chamber of the pump. Since the pressure at this point may be below atmospheric pressure, considerable air may be drawn in through the stuffing box, which is located on the suction side of the pump and always under vacuum.

Pump Seals

The water for the pump water seal should be supplied from a source with a pressure considerably higher than the pump discharge in quantities sufficient to cause a flow out of the stuffing box. Metal guards can be placed to keep excess water off the room floor. It is obvious that leaky joints, valves, and pipes, in a system through which water under vacuum is carried, present sources of probable air entrainment.

Both wear and misalignment both in impellers and pump casings, as shown in Fig. 3, will increase turbulence and are, therefore, to be avoided. Insofar as pump life is concerned, it is desirable to minimize suction lift by placing the pump as near as possible

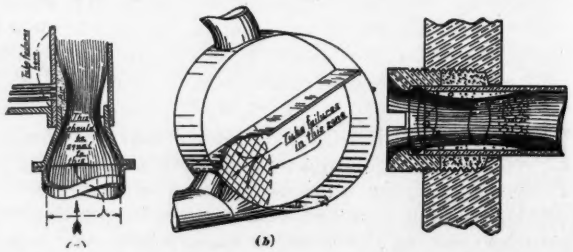


Fig. 5. Poorly designed inlet nozzles may aggravate tube failures in adjacent sections of the tube sheet

Fig. 6. Conventional ferrule at the inlet end of a tube

to the water source. Pump improvements will be reflected by savings on tubes.

In many cases, discharge piping is found with very short-sweep fittings, such as elbows and tees, which interfere with streamline flow and set up turbulence. Discharge piping with large check valves between the pump and the inlet water box, the top or head of which is at a considerably higher elevation than the top of the pipe, should be avoided.

Gate valves are also located in such pipe lines. When such valves are in a vertical position with relation to the pipe, their tops may be considerably higher than the pipe top. Such check and gate valves are excellent air chambers, acting similarly to air chambers on pump lines, virtually as shock absorbers. This shock-absorber action is accomplished by having at least half of the chamber filled with air, such air accumulating and rising as circulating water passes through the pipe.

Such collections will discharge periodically into the circulating water with the usual damaging effect on the tubes. A pipe connection should be made from the highest point on such valves to the tail pipe of the condenser, which will act as a vacuum pump. A small amount of water should be allowed to by-pass in order to make sure that no such accumulated air will enter the tubes.

Many inlet nozzles are so designed that flow is interrupted, as shown in Fig. 5. The diameter of the

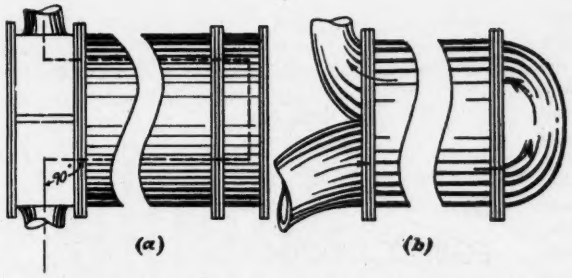


Fig. 7. Two condenser water box designs (a) the conventional type and (b) ideal from the circulating water system point of view

discharge pipe is found to be greater than that of the inlet water box, which should never be the case. The nozzle is flattened, beginning some distance from the water box. Care is taken, however, to make up for this by lengthening the opening at the water box, so that its area is equal to that of the pipe area. As water enters the water box its flow is tapered, causing a low-pressure zone at the tube sheet in line with and on the side of the nozzle. The greater the entering water velocity, the smaller the amount of water which will pass through the zone described, which, in turn, affects tube life in that zone.

Practically all inspection doors are so designed that a large recess is found between the door and the main body of the water box. This causes turbulence. Such recesses should be filled with wood or replaced with doors of special design, as shown in Fig. 4.

With high water velocity and tubes installed with ferrules extending into the water-box inlet end, tube corrosion may be found even if the circulating water enters the water box smoothly. The conventional ferrule, with bell entrance and counterbore to permit the tube to fit snugly against this counterbore shoulder was designed to bring about smoother flow. Many who install tubes with this type ferrule have the opinion that a space must be provided between the end of the tube and the shoulder of the counterbore in order to have room for tube expansion.

Figure 6 shows the conventional tube installation described. Note the clearance between the counterbore shoulder and tube end, this clearance has been found to be as much as ⅜ in. Such practice requires that the ferrules extend farther into the water box which is detrimental, but disregards the fact that the counterbore shoulder and the tube inlet end should be in permanent close contact.

All expansion and contraction of tubes installed in this way should be provided for at the outlet end. The use of a fiber packing ring in conjunction with the ferrule at the inlet end and a metallic packing with as little fiber as possible at the outlet end will accomplish this. That there are other methods allowing for expansion, such as shell expansion joints, floating heads, and a predetermined bow in the tubes when rolled at both ends, should be mentioned.

Clearance between the tube end and the ferrule counterbore shoulder forms a pocket which is ideal for causing turbulence in the water just before it enters the tube. The tube-entrance area is considerably smaller than the pocket area, causing the flow of water to assume a curvature. A low-pressure zone begins to form at the tube end, which zone will vary in length, depending upon the water velocity or the length of space between the tube end and the counterbore shoulder.

Air liberated in such recesses will obviously act destructively on tube ends, although it may return to solution on its way through the tube and cause no further damage. If ferrules of the type under consideration are examined after service, they frequently are found badly corroded just back of the counterbore shoulder.

Long ferrules have been used on the theory that corrosion might be absorbed by the ferrule itself. Extending well into the water box, such ferrules have in some cases been helpful. The author disagrees with the general theory of this practice, because the farther the ferrules extend into the water box, the greater will be the turbulence caused.

If ferrules must be used, there is a type that does not extend into the water box and makes no break in the inside diameter of the ferrule and tube; hence, uninterrupted flow results, reducing turbulence at the tube entrance.

The foregoing consideration of ferrules, as affecting inlet-end corrosion, permits a question as to why inlet-end corrosion also occurs where tubes are rolled into the tube sheet without ferrules. Such corrosion is found, but it should be remembered that water may be turbulent before it reaches the tube, due to factors discussed earlier.

Small shells may become lodged in the tubes and bake on while the condenser is hot or warm while off the line, due to leaking stop valves or entering drains. When the unit is replaced in service, a pit may occur directly adjacent to the shell on the downstream side, even though the circulating water does not carry entrained air. The water velocity passing over the shell, or any other foreign body, will produce a low-pressure area and cavitation directly in back of it. The released air concentrated in this zone does its usual damage. Tube samples with shells still attached, or with their impressions clearly visible, are in the author's possession and show pitting directly back of the shell on the downstream side.

Conclusion

Figure 7 illustrates two condensers: (a) one of the conventional design and (b) one ideal from a circulating-system point of view. It will be noted that in the conventional design water must make a 90-deg. turn at the inlet water box, with low-pressure zones on each side of the nozzle, and an accumulation of air under the division plate. In the reverse-flow water box two 90-deg. angle changes are necessary, one on leaving the first pass and one on entering the second pass.

It will be noted in Fig. 7b that the entrance to the first-pass tubes is streamlined. There is no division plate. Provision is made for entrance of water without unnecessary turbulence. This is also true of the reverse flow important from the standpoint of tube corrosion on the second pass. The author is of the opinion that with all conditions except design the same on both condensers, the tubes in the layout as proposed would last much longer than in the conventional-type two-pass condenser.

This is the first part of the third in a series of articles devoted to the modernization of power plants in various industries. The first a 3 part article on textile mill plants appeared in the Feb., Mar. and Apr. issues of 1939. The second, on the modernization of paper mill plants by K. R. Warrington appeared in July 1939. Now, we are pleased to present the first part of a general discussion of the power plant in the hotel industry. Mr. Douglas, the author is a consulting engineer who has specialized in hotel plant work and he considers the power plant from the economic rather than the technical side. Naturally, he is somewhat prejudiced in favor of the private hotel plant as compared to the use of purchased power but his arguments are sound and are supported by actual data which he presents.

By
EGBERT DOUGLAS
Consulting Engineer, New York, N. Y.

The HOTEL POWER PLANT A Stimulant For A Five

THE HOTEL INDUSTRY is one of the very important industries of this country, much more important than many people realize. According to Thomas D. Green, President and Executive Director of the American Hotel Association, the total value of hotel property in the United States is in excess of five billion dollars.

Despite its magnitude the importance of the hotel industry is not generally recognized. Many within the industry itself, operators, engineers and investors are not cognizant of the earning possibilities of this seventh largest industry in the country.

According to Mr. Green, there are approximately 20,000 good hotels in the United States, containing some 1,750,000 guest rooms. This gives an average of nearly 90 rooms per hotel with a capital investment of nearly $3000 per room. In our large metropolitan centers the invested capital is often three times this amount and there are scores of hotels on which the amount of the first mortgages alone are equivalent to $5000 or more per room. Obviously then, the broad financial aspects of this giant industry deserve serious study by both the operators and the investors in hotel securities. After all is said and done, unless a hotel returns a steady profit it is not good as security for permanent investment.

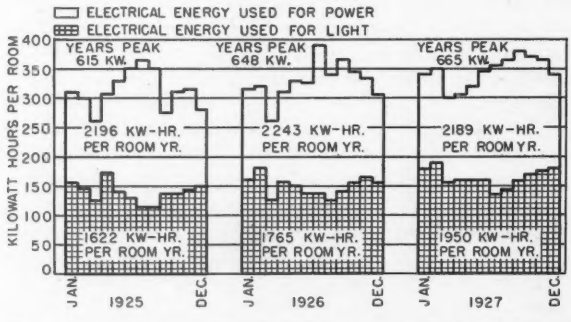


Fig. 1. Three year comparison of electrical energy used in a high class hotel of about 850 rooms

According to Mr. Green, the hotels of this country spent $16,000,000 in 1938 for insurance premiums of various kinds. This is important because there are numerous hotel properties now resting in the lap of our large insurance companies through default on their first mortgages which are owned by the investing companies. Still quoting Mr. Green: "The 500,000 hotel employes received in salaries and wages during 1938 some $475,000,000 and the hotels paid a total of $120,000,000 in federal, state and local taxes."

It is quite obvious that the hotel industry has many ramifications but in this consideration of the industry as presented here we are concerned with the heat, power and light aspect of the business. The hotel business, in common with many other lines of endeavor, has suffered from over promotion. In many cities there are too many hotels; as a consequence competition is keen and it is a case of the survival of the fittest.

The heat, light and power expenses of a hotel are largely fixed and they are not affected to a large extent by the rise and fall of business volume; they lend themselves to a very economical mixture in a common power plant.

Whether the room occupancy is 30 per cent or 80 per cent of the house capacity, the building has to be heated when the weather is cool. The working spaces, the public halls and lobbies have to be lighted and heated regardless of the volume of business. If there are 50 rooms on a floor and only 5 are occupied, elevator service cannot be cut in that propor-

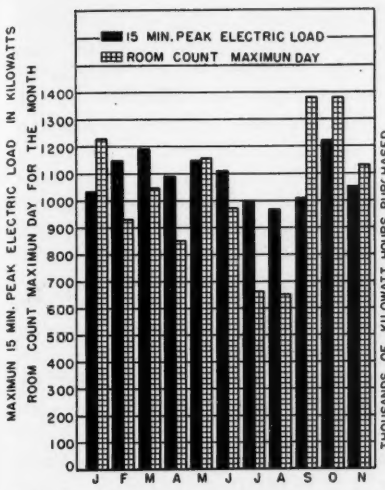

15 MIN. PEAK ELECTRIC LOAD
ROOM COUNT MAXIMUN DAY
MAXIMUN 15 MIN. PEAK ELECTRIC LOAD IN KILOWATTS
ROOM COUNT MAXIMUN DAY FOR THE MONTH
J F M A M J J A S O N

Fig. 2. Comparison of 15 min. monthly peak electric load and monthly maximum day room count of a high class hotel of about 1400 rooms. Note that the room count varied 112 per cent while the peak electric load varied only 26 per cent

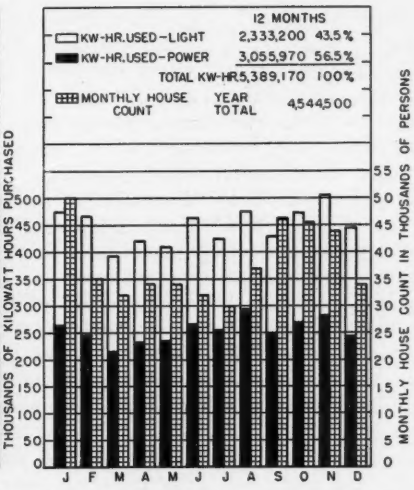

12 MONTHS
KW-HR.USED-LIGHT 2,333,200 43.5%
KW-HR.USED-POWER 3,055,970 56.5%
TOTAL KW-HR 5,389,170 100%
MONTHLY HOUSE COUNT YEAR TOTAL 4,544,500
THOUSANDS OF KILOWATT HOURS PURCHASED
MONTHLY HOUSE COUNT IN THOUSANDS OF PERSONS
J F M A M J J A S O N D

Fig. 3. Comparison of the kilowatt hours used and the house count for a first class hotel of around 1600 rooms for the year 1926. Note the uniformity of the electric power load regardless of the variations in house count

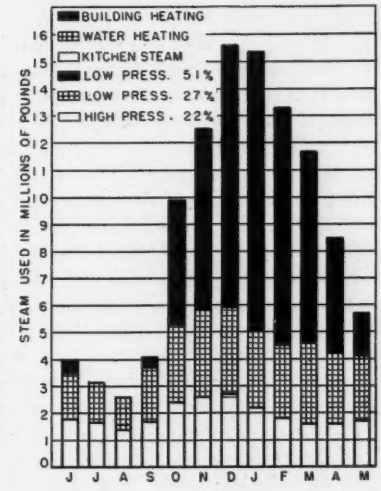

BUILDING HEATING
WATER HEATING
KITCHEN STEAM
LOW PRESS. 51%
LOW PRESS. 27%
HIGH PRESS. 22%
STEAM USED IN MILLIONS OF POUNDS
J J A S O N D J F M A M

Fig. 4. Twelve month steam consumption, average of 2 yr. for a high class hotel of about 1400 rooms. Note that 78 per cent of the steam total is low pressure, permitting the use of exhaust steam

Billion Dollar Convalescent Industry

tion. Heat, light and power expenses are surprisingly uniform regardless of business volume as Figs. 1, 2, 3 and 4 show clearly.

The relative magnitude of the heat, light and power group of expenses is important, so much so that it is surprising that so little attention has been given to it during the last decade of decreasing hotel net earnings. As an illustration of the importance of the heat, light and power group we present two notable examples, one of a hotel in the 2000 room class and one in the 400 room class. These examples follow, the case of the large hotel being presented first:

Operating Item	Amount	Per Cent
1. Administration & general expenses	$ 378,768	26.8
2. Advertising & business promotion	309,403	2.18
3. Repairs and maintenance	409,659	28.9
4. Heat, light and power	318,652	22.5
Total of the three groups	$1,416,482	100.0

From a high class combination apartment and transient hotel with 125 suites and a total of 400 rooms, we have these figures:

Operating Item	Amount	Per Cent
1. General & administration	$ 36,510	33.8
2. Repairs & maintenance	35,856	33.0
3. Heat, light and power	36,160	33.2
Total of the three groups	$108,526	100.0

Heat, light and power, it is obvious, is very important in either the large or small hotel property.

None of these items can be eliminated from the operating picture and in the use of these commodities a skilled mechanical operating crew is necessary. This essential mechanical crew can be made more profitable by making it more productive, that is to say, give it proper tools to produce things which are now purchased. Since neither the heat, light and power services nor the skilled labor incident thereto can be done away with, the combination obviously should be made more efficient by making it more productive.

As already mentioned the financial condition of the hotel industry leaves much to be desired. There are scores of hotel properties that are in default on their first mortgages, to say nothing of the millions of dollars invested in hotel junior securities that are in grave danger of being wiped out entirely.

It is extremely doubtful if room rates, which is the best revenue producing source, can be increased appreciably above the present levels to offset the prevailing red ink figures.

Similarly the raising of other revenue producing services holds out small hope of a promising nature for better earning statements, and most certainly the hotel industry cannot look to the tax collector for appreciable relief. It is only by delving into the one indispensable department of this great industry which offers opportunity for savings that it can hope to find relief from the financial worries.

The operating characteristics of modern hotels are germane to low production costs of both heat and power. These things are part of the hotel enterprise and they cannot possibly be divorced from it. The hotel power plant is as permanent as the hotel building itself. The heat demand generally exceeds the power and light demand; therefore in numerous instances the hotel steam boiler plant is in no manner changed in size by the production of electric power and light. The power and light load is, however, much more uniform than the heat load and obviously if these two loads are mixed on one boiler plant the boiler load will be greatly improved. Improving the load on any boiler by making it more uniform will lower the cost of steam. These inherent conditions are shown in Fig. 5.

The Advantage of Mixing Heat and Power in Same Plant

It does not require much imagination to see that it will take a smaller investment in power plant equipment if both the heat and power loads are taken from one boiler plant rather than dividing these loads between two boiler plants. No hotel would wash soiled linen in its own laundry and then send it to another laundry to be ironed. Combining the washing and the ironing in the same plant is highly economical. Combining the heat load and the power load on the same boiler plant is likewise economical. Hotel heat and power loads are such that combining them in a common boiler plant is not only a simple matter but a highly economical one, both from the standpoint of plant investment and its overall efficiency. The improvement in efficiency is due to a combination of two things, first a very large heat recovery by the use of exhaust steam from the power producing engines, and, second, a good boiler load throughout the twelve months of the year and the 24 hours of every day. The improved boiler loading has a marked economical effect on the efficiency of the boiler plant. The high annual load factor of the hotel electric load contributes towards the more uniform boiler loading in a pronounced degree.

This natural advantage of the hotel power plant has escaped the attention of financiers, mortgage holders, hotel executives and hotel designers to a marked degree. The potential earning possibilities of the hotel power plant is a bright spot in the convalescence of a sick industry.

For a given power demand the hotel consumes more energy than many other lines of industry. The annual electric load factor of hotels is well over 50 per cent and in many cases the annual use of the peak load will average well over 55 per cent. The writer knows of many cases where the annual use of the year's peak is well over 5500 hr. This is illustrated in Fig. 6.

The ordinary "run of mine" industrial establishment operates about 3000 hr. per yr. but hotels operate 8760 hr. per yr. The hotel would operate longer but there are no more hours. The hotel electric load hangs on fairly steady regardless of the number of rooms occupied or the number of people in the house.

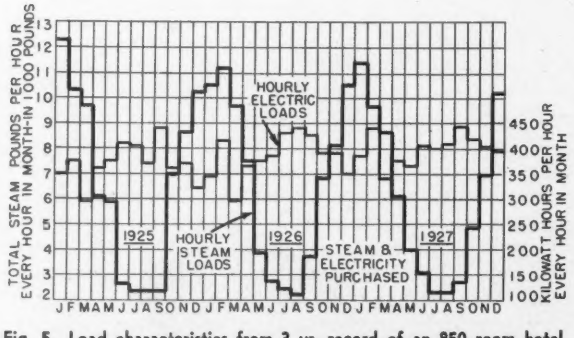

TOTAL STEAM POUNDS PER HOUR EVERY HOUR IN MONTH-IN 1,000 POUNDS
KILOWATT HOURS PER HOUR EVERY HOUR IN MONTH
HOURLY ELECTRIC LOADS
HOURLY STEAM LOADS
STEAM & ELECTRICITY PURCHASED
1925
1926
1927
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D

Fig. 5. Load characteristics from 3 yr. record of an 850 room hotel, each with private bath. Building gross volume 7,300,000 cu. ft. Includes steam and electrical energy for all purposes except laundry. Note uniformity of loads from year to year. If these two loads were combined on one boiler plant it obviously would take less load than serving them from two boiler plants

In a hotel the same steam which drives the engines will also, for a considerable part of the time, warm the building and heat the water. This is accomplished with substantially no additional investment in the boiler plant because the maximum steam demand is usually caused by the heating load. The hotel heat load is generally in excess of the steam demand for the production of electric power and light. Figures 7 and 8 show the attractive features of the hotel steam and electric loads.

Heat, Light and Power Are Permanent Expenses

In seeking more economical means of obtaining heat, light and power in the hotel industry we are attacking one of the major groups of operating expenses. These commodities cannot be dispensed with. Not only must rooms be heated in winter but hot water must be available in abundance at all times. Refrigeration also is a continuous necessity. These things are opposites but they are both products of heat energy and the heat coming from the refrigerating engine can be used to help warm the building or heat the water.

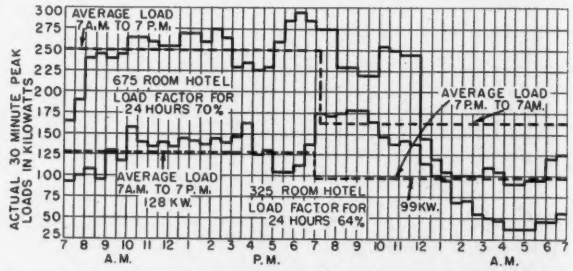

ACTUAL 30 MINUTE PEAK LOADS IN KILOWATTS
AVERAGE LOAD 7 A.M. TO 7 P.M.
675 ROOM HOTEL LOAD FACTOR FOR 24 HOURS 70%
AVERAGE LOAD 7 A.M. TO 7 P.M. 128 KW.
AVERAGE LOAD 7 P.M. TO 7 A.M. 99 KW.
325 ROOM HOTEL LOAD FACTOR FOR 24 HOURS 64%
A.M.
P.M.
A.M.

Fig. 6. Actual electric loads for 24 hr. for two moderate size hotels. Both purchasing all electricity and making all steam, including that used for refrigeration. Note the similarity of the load curves. While one hotel is twice the size of the other the load curves are very much alike

Elevator service is a continuous necessity. There are more than 15,000 elevators installed in the modern hotels of this country and when it is considered that each passenger elevator represents an investment of around $25,000, an idea of the magnitude of the elevator investment is obtained.

In an address at the 28th annual convention of the American Hotel Association in Galveston, Tex., in 1938, C. B. Connor of Horwath and Horwath, Public Accountants, said that hotels spend on the average of 15 per cent of their room sales or $92.00 an available room a year on light, heat and power.

These expenses differ widely in different hotels, however. Quoting Mr. Connor, "In our study for 1937 they were found to be as low as 5 per cent of the room sales $52.00 per available room) and as high as 28 per cent of the room sales ($185.00 per available room)."

Costs On Room Unit Basis Misleading

Dependable results in a steam boiler or electric generating plant cannot be measured by comparing operating results on the costs per occupied room. The quantities of steam a hotel uses for heating the building will obviously vary greatly with weather conditions. It will not be changed materially by the number of occupied rooms or the house count. The steam used

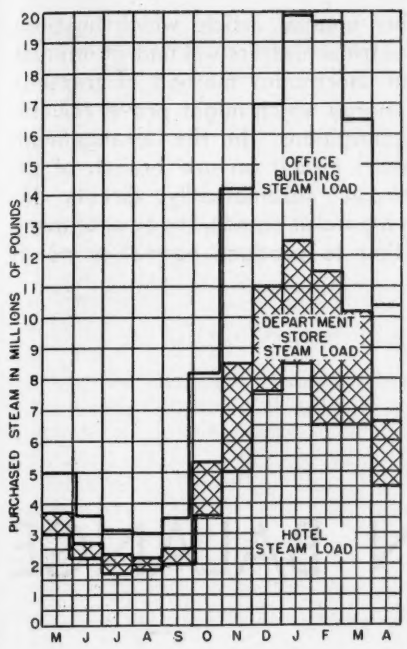
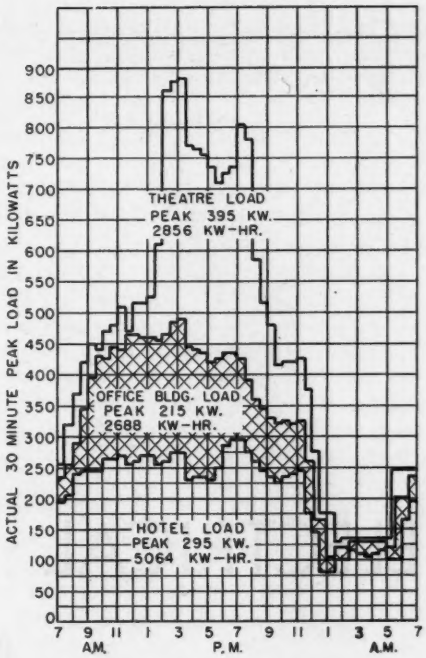

PURCHASED STEAM IN MILLIONS OF POUNDS
OFFICE BUILDING STEAM LOAD
DEPARTMENT STORE STEAM LOAD
HOTEL STEAM LOAD
M J J A S O N D J F M A

Fig. 7. (Left) Characteristic steam loads of hotel without laundry, office building, and department store. In the 6 mild weather months the hotel used 30 per cent of the year's total, the department store 18 per cent and the office building 19 per cent. The average hourly steam loads for the year as a percentage of the maximum hour load are as follows: hotel 52 per cent; department store 44 per cent; office building 46 per cent

Fig. 8. Electric load characteristics of three types of commercial buildings. The kilowatt hours used per kw. of plant peak are as follows: hotel 17.2, office building 12.5, theatre 7.2. Note how relatively flat the hotel load is as compared to the other two types of buildings



for warming the building is the major part of the total steam, particularly so in the climatic belt where the heating season is from 8 to 9 months long. The character of the hotel is important, it is quite possible that one hotel may have a large amount of public space while another hotel having the same number of rooms may have very little public space. A comparison of costs per room year of two such hotels is obviously worthless.

Similarly, in comparing the consumption of electricity on a room basis we may go far astray. One hotel may have twice the ventilating load of another hotel of similar size. One hotel also might be producing its refrigeration by steam engines while another might be using electric motors for this purpose. This difference will affect not only the electricity consumption but also the steam figures.

Furthermore, room unit comparison may be deceiving because some hotels overstate the number of rooms. For example, we know of one hotel advertising 1600 rooms that actually has about 1400. Another advertises 800 and it actually has less than 700. It is not known to what extent these distorted room figures are used in accounting cost figures but obviously if such figures are used comparison of costs are worthless.

On the other hand, unless the ratio of the number of rooms to the cubic feet of building volume to be heated and climatic conditions are taken into account, the steam figures may be questioned in numerous cases.

It is quite evident that while these things are important in hotel operating problems and that substantial savings can be made, they cannot be realized on the basis of guesswork. If the proper facts are considered, substantial savings can be uncovered. There can be only one set of facts and if we hold to these there can be no question about the right answer.

In another article we shall present a comparison of the actual heat, light and power costs of two prominent hotels, one of which generates its own power and the other purchases its power.

Flyash Identification

Microscopic Studies of flyash frequently make possible correct determination of its source. And the results of two such studies were reported to the S. P. A. by J. F. Barkley, Supervising Engineer, Fuel Economy Service, Bureau of Mines.

For example the Supreme Court Building, one of the finest of the Federal buildings in Washington, was having much difficulty with flyash from some outside plant. It was considered to come from a nearby apartment house. A flyash trap was installed there and care was taken in the operation of their underfeed stokers. The flyash nuisance continued. A microscopic examination of the flyash found about the building as compared to samples taken from the stack of the apartment house showed to the surprise of the accusing building superintendent that at least the present source was elsewhere.

By the same means, the source was found to be a plant about ½ mi. away. Whether or not the nuisance is the result of a combustion process may also be revealed. In one case, accumulation of particles creating a nuisance at another Federal building was found to be about 90 per cent of material from sources other than the accused heating plant in the next lot.

A general microscopic research on flyash might reveal distinguishing characteristics relating samples to various fuel burning conditions or fuels. Such knowledge would be very valuable and in special cases where it seemed desirable to create an easily distinguishable characteristic in the flyash, it might be possible, he said, to blow into the gases special, easily detectable particles; or some of the flyash taken from the stack gases might be colored and blown back into the stack.

Here is a rather unusual article which anybody interested in electrical matters will find of interest. It deals with an unorthodox method of transmitting electrical energy which might prove valuable under certain conditions. In the arrangements considered a short circuit on one branch of the transmission circuit automatically directs the energy through a parallel branch, the two, or more, branches reuniting to produce normal or nearly normal results.

ELECTRICAL ENERGY IN BALANCE

BY JOHN K. MASTEN

HAVING TOYED with ideas employing combination differential gear arrangements, the numerous effects attainable were found to be both odd and interesting. The simplest of these is of a nature which when utilized for the transmission of electrical energy, produces a result which may be worthy of further consideration as to whether it might not be desirable for practical purposes.

In elementary studies the student learns in a general way that electricity flows through the path of least resistance. In this article at least this rule is best restated: "Electrical energy travels the paths of energy consumption." As electrical and mechanical energies are about to be considered in conjunction with one another we now have a basis for analysis between the two, for where mechanical energy is split into two paths by a differential unit it chooses proportionately the path of energy release. An example of this may be noted in the action of the rear wheels of an automobile if one is jacked off the ground—any power supplied to the drive shaft is released by the free wheel and little energy is consumed.

Here we have two circuits of energy transmission choosing the paths of least resistance; electricity the path of energy consumption and mechanical energy the opposite path of release.

In general practice it appears that the original rule may be taken for granted, but as electrical and mechanical energies can be converted back and forth from one to the other, the question arises: "What might be the practical applications of electrical energy flowing through the paths of greatest instead of least resistance?"

Various arrangements are possible in which this may be accomplished the first of which is to operate a generator at each of the two sides of a differential unit. The generator producing the greatest resistance to motion, because of electrical consumption, will stop.

To lead up to one of many seemingly practical applications the mechanical circuit shown in Fig. 1 is useful though its action odd.

Mechanical Energy In Balance

If two differentials D are connected by belt using shaft A as the input and B as the output a unique action is obtained. It is to be expected that the output B would practically duplicate in power, torque and speed, that of the input A even though one of the belts is held stationary but the fact that either of the belts may be stopped with a negligible amount of effort creates the impression that no great power could be passing through it, an idea quickly corrected if an attempt is made to retard both belts simultaneously. This effect is produced by the delicate balance between the sides and "shorting" one side simply relays the energy through the other.

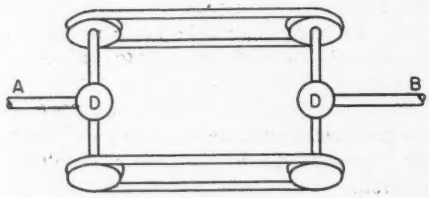


Fig. 1. Left. A mechanical system of transmission involving two parallel circuits in balance

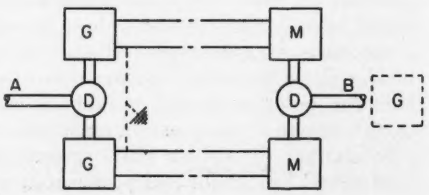


Fig. 2. Right. The electrical counterpart of the mechanical system shown in Fig. 1

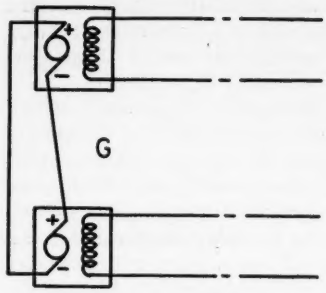


Fig. 3. Showing the use of separately excited fields to more nearly approach the desired conditions of operations

ELECTRICAL ENERGY TRANSMISSION

By substituting a means of electrical transmission in place of mechanical as in Fig. 2 by employing generators G and motors M in place of the belts the results at output B still approximate those at input A. Electrical or mechanical drain on one branch in excess over the other from any cause produces action parallel to that of Fig. 1 stopping the one branch and directing the full amount of energy through the other with only a partial and momentary variation in the output. One branch still tends to alter inversly to the other.

In analyzing the effects, the relative revolutions per minute, horsepowers and torques must each be carefully considered separately as these do not vary in direct accordance with one another in the branch lines.

Such devices as locks, brakes, reverse motion preventors, etc., are details not necessary to the presentation of this principle and in setting forth this outline the use of transformers and accessories such as would be required in practical application are omitted.

As conditions of torque most directly affect the action of the differentials, special generator construction should be considered in conjunction with this circuit for the purpose of preventing wide torque variations during periods of unbalance. Separately excited fields or circuits of the type of Fig. 3 more nearly approach the desired condition than customary units. In the latter case the armatures excite each other producing the required direct current, any deficiency in one branch being compensated for by the other, thus creating desired relations of torque with abnormal distribution of energy flow. The stationary windings supply the lines of transmission.

Such arrangements enable uninterrupted service during short circuits as either line carrying half the current automatically accepts the full burden of transmission without increased line drop, when unbalance occurs from any unwanted mechanical or electrical drain upon the other side.

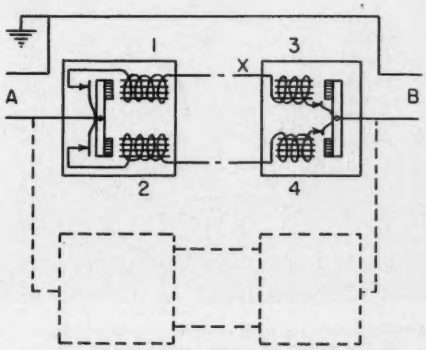


Fig. 4. A telephone bell type of construction which may be applied to any number of parallel circuits

True enough, the differential units present an additional factor to be contended with in the quest for a foolproof system therefore the next natural step is to substitute electrical units in their place.

The telephone bell type of construction as represented in Fig. 4 which while not simulating such a human action produces practical and relative results.

All contacts are normally closed. Briefly, a short in line X causes coil 1 to momentarily become the most energized opening that contact, provision being made to automatically lock it open. This armature must be the quickest in action. The coil 3 automatically becomes the least energized reversing its polarity and opens its contact. No lock devices are required. Unlike the arrangement in Fig. 2 these operations are sudden rather than gradual.

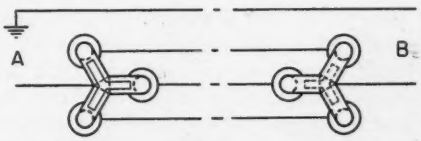


Fig. 5. An arrangement for operating three or more branches from one set of control units

The output units action is much simpler and superior as it automatically responds to open as well as short circuits while the input unit must be manually reversed in the event of open circuit. Any complete current lapse in the circuit will reset the output unit.

Separate soft iron armature cores produce widely applicable results for either alternating or direct current while special effects may be obtained with steel or variations of construction.

In simple circuits, much additional transmission line copper is required but by the use of other parallel lines as represented in the dotted portion of the Fig. 4 the total amount of copper becomes less. Mathematically speaking, with an infinite number of lines there would be no more copper necessary than in present systems.

Unit construction as represented in Fig. 5 enables three or more branches from one unit and results in copper saving. The armature may consist of a desired number of fingers and have a semi-universal motion permitting at least one line to open at a time.

The units can be made very sensitive to transmission line drain but will be unaffected by overloads at B.

Voltage compensating devices must be considered especially where two branches are employed.

Variable resistors across each coil enable adjustment of the units to accurate balance.

The purposes of this article are to emphasize the fact that electrical energy by manipulation can be made to travel the most difficult path of energy release and to demonstrate that practical applications might well be developed to employ such principles. The possibilities are by no means restricted within the narrow confines herein outlined.

Some Electrical Developments In 1939

A brief consideration of some of the more interesting electrical developments made during the year 1939 to indicate the character and the broad range of progress. As pointed out below this in no way attempts to be comprehensive and most of the developments listed were selected at random from a large amount of data released by various manufacturers.

THE year 1939 was a notable year in electrical progress. There were major advances on an extremely broad front both in equipment and methods for the production and distribution of current and for the increased and improved application of electricity in industry, commerce and the home. Kilowatt-hour consumption set an all time high record with the increase particularly emphatic in the final quarter of the year. There were several weeks in which the output of the light and power industry exceeded 2½ billion kilowatt-hours. In the field of steam-turbine power generation there was emphatic progress in the use of high pressures and temperatures for the turbines and of hydrogen cooling for the generators; in the hydroelectric field activity was much greater than normal. Particularly outstanding in the field of power transmission and distribution were the new oilless circuit breakers.

It would be presumptious on our part to attempt in the space of a couple of pages to present a review of even the more important electrical developments but it may be of interest to consider a few of them more or less at random from data submitted by the principal manufacturers. Those presented here may not all be among the most important but all of them are characteristic of the type of development that has proceeded on all fronts.

In the use of electric power in industry there were such conspicuous advances as the new Amplidyne system of automatic control of speed and power particularly applicable in steel mills. Other developments included the sealed-beam automobile headlight, further improvements in fluorescent lighting, the introduction of television in a limited way, the operation of frequency modulated radio transmitters with improved quality of programs and almost complete freedom from static, the use of radically new gas insulated X-ray tubes of million volt ratings and the application of a new enameled wire, Formax, which offers advantages marking it as the first major improvement in enameled wire covering in 30 years. The Amplidyne and Formax are both General Electric Co. developments.

Many companies, including G. E., Westinghouse and Allis-Chalmers, developed new types of air circuit breakers, indeed the trend toward the use of air circuit breakers for voltages and power heretofore only covered by oil circuit breakers was one of the major features of the year's progress.

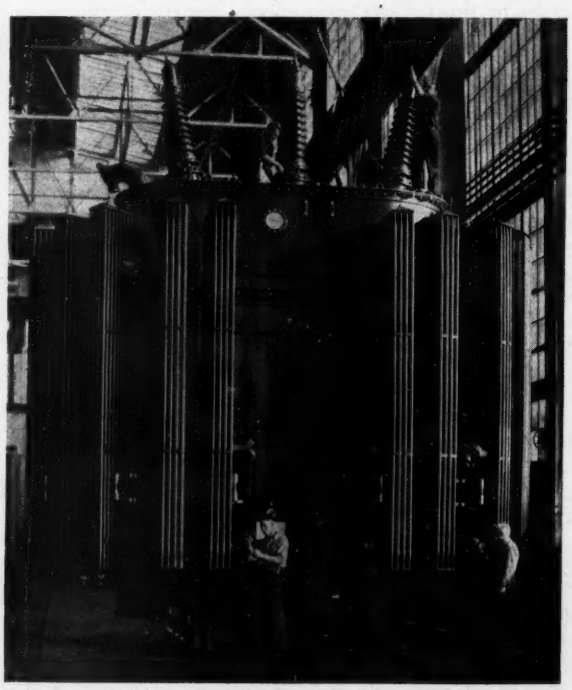
Electronic technique increased by leaps and bounds, not only in the industrial applications but in fundamental technique. New principles in the generation of high frequencies have shown great promise. At the Institute of Radio Engineers' meeting in Rochester in September, A. V. Haeff and L. S. Nergaard of R. C. A. Radiotron described an inductive output beam type amplifier which generated 10 watts at 500 Mc. With more conventional methods, a power output of 56 kw. in two tubes at an efficiency of greater than 50 per cent has been produced experimentally on frequencies in the neighborhood of 100 Mc.

Of particular interest to those engaged in the development of frequency modulated radio transmitters was a cathode ray modulation generator devised by R. E. Shelby of the National Broadcasting Co. A most ingenious device, this produces frequency modulated signals with phase angles in excess of 360 degrees.

The year witnessed a considerable increase in the use of mercury arc rectifiers of both the ignitron and grid controlled type. Among the larger rectifier installations were two 18 anode, 3000 kw., 630 v. rectifiers made by Allis-Chalmers for an Eastern traction system.

Westinghouse also produced a number of 3000 kw., 640 v. ignitron rectifiers for use on the New York Central Railroad.

A new portable X-ray flaw detector for locating flaws in industrial products was developed by Westinghouse and placed in service at the East Pittsburgh Works of that company. This equipment is extremely



The largest transformer ever built in terms of power output. This giant transformer rated at 50,000 kv-a. self-cooled and 66,667 kv-a. with the addition of air cooling was built by G. E. for the Oswego Station of the Central New York Power and Light Corp.

compact, and though built for 220 kv. may be wheeled along production lines to maintain the quality of equipment during manufacture. Shockproof, completely self-contained, it generates X-rays with a penetrating quality sufficient for them to pass through 3 in. of solid steel.

In the smaller sizes, air cooled turbine generators still prevail but in the larger sizes the trend is towards hydrogen cooling. At the Schenectady plant of General Electric nearly 1½ million kv-a. of hydrogen cooled turbine generators were under construction at the end of the year. Thirteen Schenectady built hydrogen-cooled generators with a combined output of 816,000 kv-a. were in operation. This is quite remarkable when it is considered that the first hydrogen cooled generator was placed in service only two years before.

Developments in switchgear were particularly important. The most powerful oil circuit breakers with an interrupting rating of 3½ million kv-a. at 287,000 v. were built and a number of new oilless breakers introduced. Two of the latter developed by G. E. included an air blast breaker in the larger sizes and a magnetic blow-out type for low voltage systems.

In terms of kv-a. rating, the largest self-cooled transformers with air pressure cooling yet built at the Pittsfield works of G. E. were produced for the Oswego station of the Central New York Power and Light Corp. This is rated 3 phase, 60 cycle, 50,000 kv-a. self-cooled and 66,667 kv-a. with the addition of air cooling.

Many New Types of Control Equipment

As electrical equipment is called upon to perform more and more functions and as the functions become more complex, there is a demand for new types of control equipment. Simultaneously there is a demand for improved models of existing devices. On both of these fronts there were important advances. In this field, the Amplidyne has already been mentioned. This is essentially a motor driven, compensated generator with an extra set of brushes for each set of poles and it was developed to provide an efficient and economical way of handling and controlling large amounts of power. It gives exceedingly high amplification of d.c. input and is particularly suited to many control applications. Amplidyne control was widely and successfully applied in various steel mill equipments—as a current regulator for cold-strip tension reels, as a speed and current regulator for flying sheers, for more special strip grinders and for numerous other applications of a similar nature. Several hot-strip mills built 10 to 12 years ago were modernized by this system, increasing their maximum delivery speeds to 1600-1800 r.p.m.—almost equaling most recently constructed mills.

Refrigerant Cooling for Compressor Motor

In the field of electric refrigeration the newly developed 100 ton 16 cylinder hermetically sealed air conditioning compressor of the Westinghouse Electric and Manufacturing Co. is of great interest. Extremely compact, this 90 deg. V-type unit requires but ⅓ the space and is but ⅔ as heavy as conventional compressors for the same capacity. From the electrical standpoint it is of particular interest in that it uses refrigerant cooling for the motor, sealed-in lubrication and a reversible oil pump to prevent harm when phases are inadvertently reversed on the electric power system. Entering through the end bell of the motor the dense, cold, suction gas (Freon) sweeps around the stator windings, through the rotor and air gap absorbing heat from the motor. A special manifold then delivers the gas to the cylinder head.

Outstanding among the radio developments of the year was the way in which the Armstrong frequency modulated broadcasting system assumed importance. Exhaustive field tests were conducted during the year and new transmitters and receivers were developed by General Electric.

These transmitters utilize the first really fundamental change in the system for broadcasting since its inauguration two decades ago. Its appeal is the promise of noise-free, high fidelity broadcasting.

Both the electrical and mechanical features of carrier-current equipment were improved during the year. Maximum use of standard units in the growing diversity of power-line applications was attained by a standardized rack and panel assembly and new circuits were provided to accommodate an increased number of channels on the same transmission line and to provide easy adjustment of all carrier-frequency and audio circuits to obtain essentially uniform characteristics in all such adjacent channels.

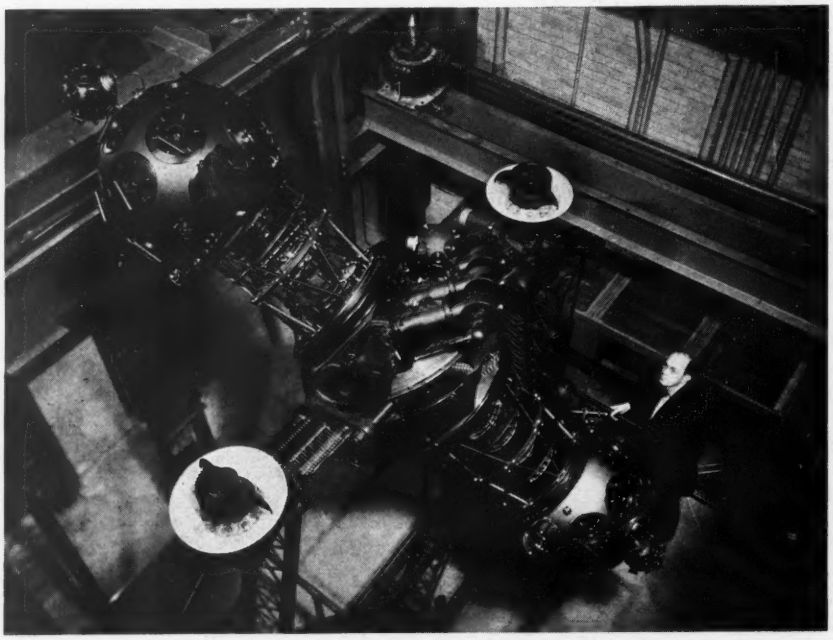
All Electronic Automatic Synchronizer

In the field of electric control, Westinghouse developed a new automatic synchronizer in which all interlocking relays are eliminated and their functions performed by electronic means. The internal circuit of this synchronizer comprises two thyratron tubes, transformers and several rectifiers, condensers, resistors and a breaker closing relay. This relay is the only moving part in the synchronizer. This electronic synchronizer has been installed on some of the recent units at Boulder Dam where its performance has shown it to be far superior to that of the interlocked-relay type. The synchronizing performance is more consistently accurate because the electronic interlocking feature is coordinated with the actual speed of the circuit breakers involved. Of equal importance to the peace of mind of the operating personnel is the relatively smooth synchronizing of the incoming machine and the almost complete elimination of "grunt" as the generator circuit is closed.

A CIRCULAR-PIPE water spray may be installed at the base of the stack below the point where the breeching enters for wetting down fly-ash accumulations. Sometimes a simply designed spray of some type is installed above the breeching entrance, for intermittent use whenever the boiler tubes are blown. Such a spray lowers the temperature of the flue gases and will thereby lower the draft available from the stack.

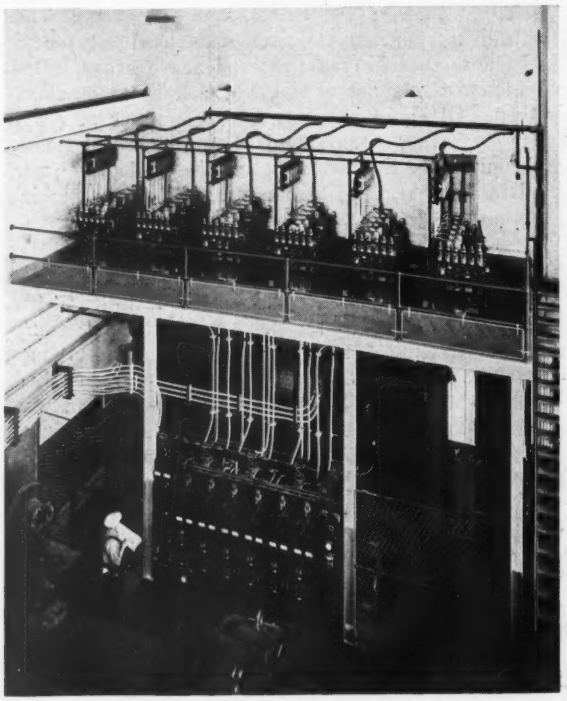
The water picks up sulphurous gases and becomes acidified; considerable water vapor goes into the stack gases. Various corrosion problems may develop in any attempt to use such a scheme with the water flowing continuously. However, for intermittent operation with rather long time intervals, such equipment is kept dry by the flue gases the greater part of the time and has given satisfaction.

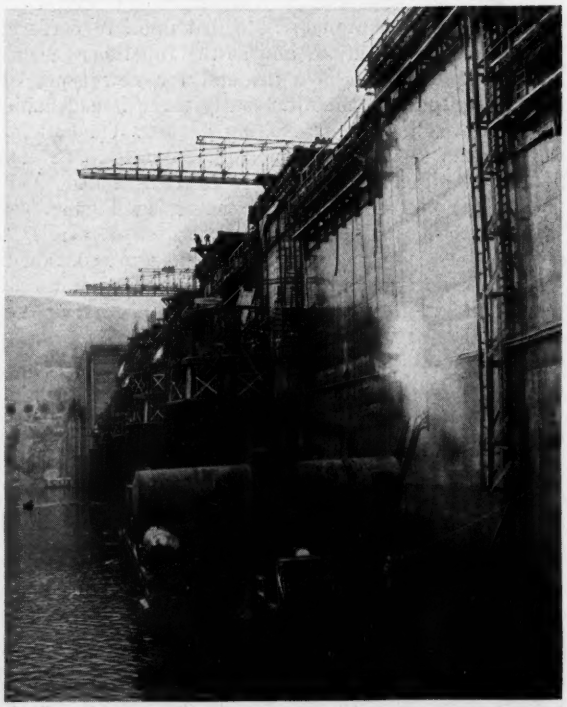
PICTURES of Engineering



Elevator for Stars. Director James Stokley of Pittsburgh's new Buhl Planetarium rides the unique elevator platform on which a 134,000 projector is lifted from a basement pit into "shooting" position in the planetarium auditorium. Engineers of the Westinghouse Electric Elevator Co. designed the lifting equipment to operate with a 20 hp. motor. Because of the value of the 106 lens projector the lifting mechanism is equipped with safety switches to prevent collision between the disappearing floor and the rising projector. By watching a series of small green lights on the control panel, the operator can follow every movement of this apparatus. Two motors with a combined output of 9 hp. operate the 6000 lb. floor.

Below is shown a group of six ignitron rectifiers which have been supplying a total load current of 4800 amp. almost continuously for the Buffalo Electro Chemical Co. for over a year. They are Westinghouse units and each supplies 800 amp. at 280 v. to a bank of cells for the production of hydrogen peroxide. Mounted on a balcony above the transformers, the equipment requires small floor space.



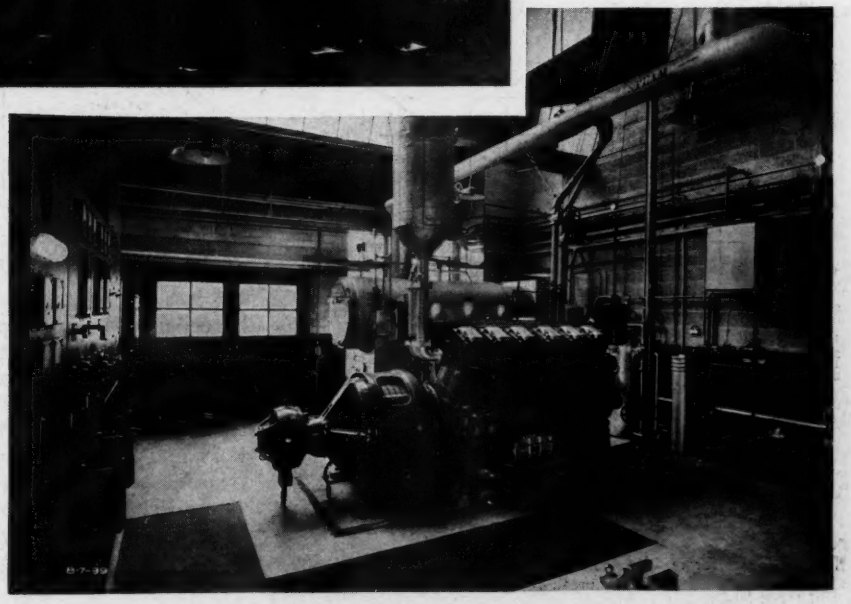


(Above) A steam heating plant anchors beside Grand Coulee dam to protect new concrete during zero weather. They call it the "Iron Duke." Steam pipes connect with the 5 ft. layer of newly poured concrete lest it freeze. The steam heating system safeguards the concrete against the bitter weather which can be expected at Grand Coulee in winter.

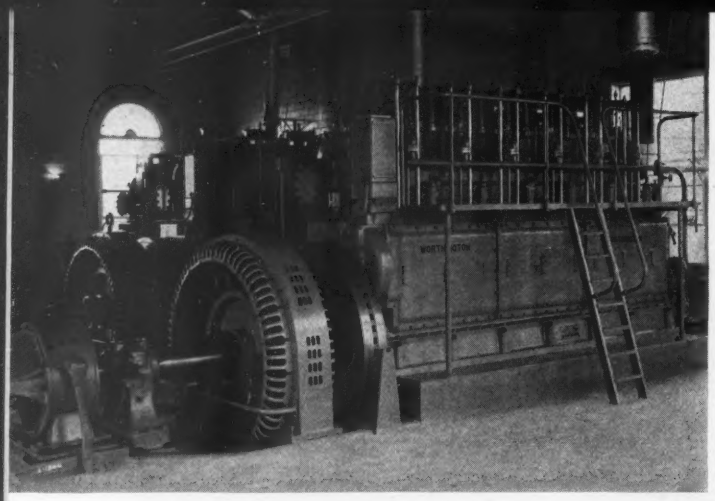
Interest

No. This is not a group of witches stirring their mysterious cauldron, but a group of mechanical doctors (arc welders) doing a major operation. Such operations are now as common in the industrial world as appendectomies are to the average person. This particular operation was to repair a break in a puncher head of a scale which stopped an entire steel mill. Four hundred pounds of steel in the form of arc welding electrodes supplied by The Lincoln Electric Co. was melted into the casting.

(Left) A group of 30 interested steel company and utility company electrical engineers from the East and Middlewest recently visited Allis Chalmers special switchgear laboratory in Milwaukee where they witnessed the first special demonstration of Allis Chalmers new air-blast circuit breakers. The new breakers use the stored energy of compressed air for the two fold functions of breaker operation and arc interruption. These switch breakers are made in capacities up to 500,000 kv-a.



(Right) This Cummins VL. 500 hp. diesel engine is direct connected to a 250 kw. generator and furnishes all the power for the Cummins Engine Company's new injector and fuel pump division is synchronized with the main power room serving other buildings in this plant at Columbus, Indiana. Adequate space for the installation of a second unit has been provided. This building uses tree-form columns to support a saw tooth roof without intermediate web members, others providing unobstructed head room which simplified the layout.



A typical modern Diesel power station with three engines totaling 1165 hp.

While the advantages of the Diesel or gas engine for the production of "cold" power have long been recognized, only recently has advantage been taken of the "plus"—the tremendous quantities of heat available in the jacket water and exhaust gasses

By J. F. HECKING
Worthington Pump & Machinery Corp.
Buffalo, New York

Cold Power Plus—

HEAVY DUTY DIESEL engines are accepted generally as a practical method of producing power for direct utilization or for the generation of electric current for they have a higher thermal efficiency than any other commercial type of prime mover and use the fuel which is readily available at a reasonable cost practically everywhere. A typical modern Diesel power station, the Shenandoah Valley Electric Co-operative is shown by the headpiece. Where natural gas or some other fuel gas is available at a reasonable cost it is customary to install heavy duty gas engines built along substantial lines quite similar to the stationary Diesel engines. In fact, certain makes of gas engines are built so that they may be converted to burn fuel oil at short notice should the use of such fuel result in a more advantageous power cost.[1] Such a plant is shown in Fig. 4. The modern sewage disposal plant definitely calls for the installation of gas engines to operate on the gas generated during the digestion of the sludge. Large projects of this sort[2] are now in regular operation in New York and other large cities in the United States.

Figure 1 provides a convenient means of estimating the cost of producing electrical energy by either Diesel or gas engine, or comparing one fuel with another for use in convertible engines. In this chart

[1]See Gas Engines for Louisiana Utilities, by F. H. Coughlin. P. P. E., p. 298, May 1939.

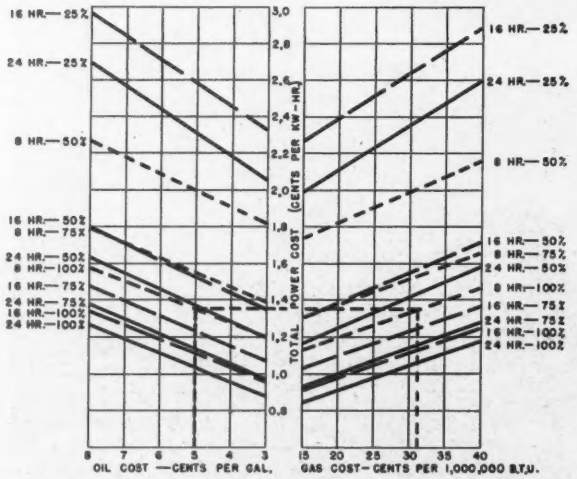


Fig. 1. Chart for rapid calculation of total power costs with either gas or oil engines

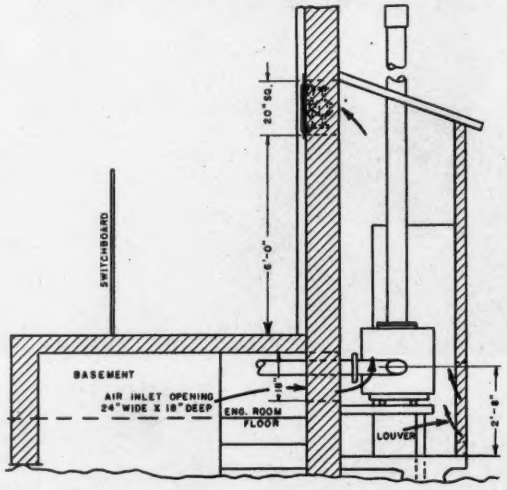


Fig. 2. Arrangements of this kind have been found an effective, cheap and convenient means of heating stations

the items of maintenance, labor, lubricating oil and miscellaneous plant expenditures are based on values as reported in recent A.S.M.E. reports. Interest charges of 6 per cent are charged on a total average plant cost of $120 per kw. for the complete engine plant exclusive of the building. On this investment, taxes and insurance are taken at 2 per cent, depreciation is based on a 20 yr. life with a 4 per cent funded rate of 3.5 per cent annually. The same values apply

[2]See Sewage Makes Good Power (La Crosse, Wis.), by C. A. Wahlstrom and H. T. Rudgal, P. P. E., p. 571, September 1938; also Peoria (Ill.) Plant Generates Electric Power from Sewage, P. P. E., p. 506, September 1936.

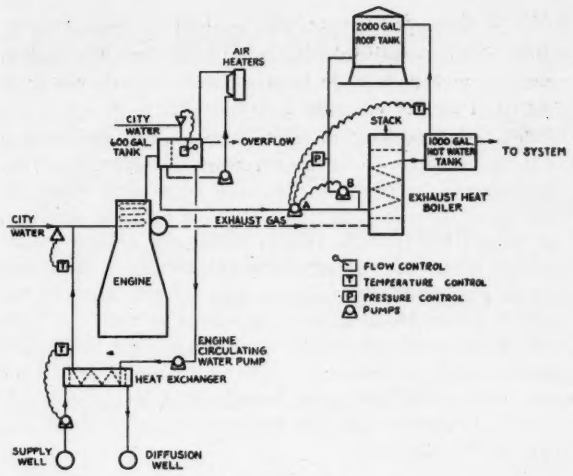


Fig. 3. Simplified flow diagram of the jacket water cooling and heat recovery systems in a large metropolitan department store. When pump A is stopped automatically pump B is started so as to maintain circulation through the waste heat boiler while the engine is in operation

for the gas engine plants. The chart is to be used as follows: Should fuel oil cost 5 ct. per gal. the total power cost is seen to be 1.35 ct. per kw-hr. on an 8 hr., 100 per cent load basis. Should the load average 75 per cent of rated capacity during this period the total power cost increases to 1.55 ct. per kw-hr. Power costs with gas engines are obtained in the same way using the right hand side of the chart.

Starting with the reading of 1.35 ct. on the vertical scale, as obtained for the eight hour 100 per cent load, the line may be continued across until it meets the corresponding gas engine load line from which it is followed down. This shows that if fuel oil at 5 ct. per gal. is available for an oil engine, gas to be competitive must be available at a price not more than 32 ct. per million B.t.u. for a gas engine. For natural gas having a heat content of 1000 B.t.u. per cu. ft. the corresponding fuel gas cost would be 32 ct. per 1000 cu. ft. If the heat content were only 500 B.t.u. the gas should not cost more than 16 ct. per 100 cu. ft. in order to balance the costs.

Standby

The chart is based on the installation of the minimum horsepower for the given demand. Conditions frequently require the installation of reserve capacity and this materially increases the fixed charges. Amortization policies also vary widely. Many instances arise wherein the items of interest on the investment, labor and depreciation are entered only as nominal items, particularly in so-called payment-out-savings applications, and these may materially lower the total power cost. Again the chart applies only to the generation of electricity which may be termed "cold" power. There are, however, many applications which require greater or lesser amounts of heat in the form of hot air, hot water, or steam. It is the ability of Diesel engines and gas engines to produce appreciable quantities of such heat which justifies their application in many instances, even though the cost of engine-produced electricity is substantially the same as that of purchased current.

Need for heat in the isolated power and light plant and in the industrial power plant is usually limited to the heating of the building in cold weather and providing warm water for the service taps. A common method of handling heating problems is to make steam or hot water in exhaust heat boilers and to send this at 5 or 10 lb. pressure to unit heaters located around the building. Where heat is required for the power plant alone a simple method is to build a dog house around the silencers with louvres on the far side and a fan on the building side as shown by Fig. 2. In this construction fresh air from outside is drawn through the louvres over the silencers and discharged to the engine room. Since 20 to 30 per cent of the heat in the fuel goes into radiation and exhaust, appreciable quantities of heat are available in this way. Additional heat is allowed to enter the engine room through grills in the floor over the exhaust piping of one or more units. A plant of the direct hot air type in Minnesota reports that the small night load Diesel engine held the room temperature up to 60 deg. F. when the outdoor temperature dropped to minus 35 deg. F.

Heat Calculations

Heat available for recovery can be understood better by considering the running characteristics of a 375 hp. Diesel engine. The current output at full load is 13 kw-hr. per gal. of fuel, the exhaust temperature is 700 deg. F. and there are 4085 lb. per hr. of exhaust gas. The jacket water amounts to 37,500 lb. per hr. of 130 deg. F. water. When hot exhaust gas is passed into an exhaust heat boiler and part of the engine jacket water is used as feedwater for this boiler, it is possible to generate 325 lb. per hr. of 10 lb. steam. Should the circulating water go to the engine jackets at 100 deg. F. there should be available, in addition to the steam generated at full load, an additional 37,000 lb. per hr. of water at 130 deg. F. water. At reduced loads the steam output falls off due to the lower exhaust gas temperature but even at half load about 125 lb. per hr. of steam should be available.

Production of hot water alone, either for direct utilization or as feedwater to a regular boiler plant, naturally results in greater volumes becoming available. Should a temperature of 130 deg. F. be sufficient, the 375 hp. engine should deliver 37,500 lb. of it per

Fig. 4. Two 700 hp. convertible gas-oil engines now operating on gas in the West Texas field

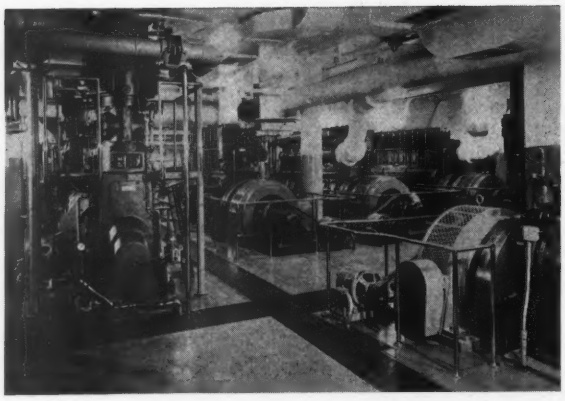


Fig. 5. These five Diesels in Namm's Department Store, Brooklyn, N. Y., total 1330 hp. A simplified flow diagram of the heat recovery system is shown by Fig. 3

hr. at full load without utilizing any of the exhaust heat. With little change 150 deg. F. water can be produced. If the water is desired at a still higher temperature it can be obtained by passing some of the 130 or 150 deg. F. water into an exhaust heat boiler. In this way about 7500 lb. can be raised to 180 deg. F. while leaving 30,000 lb. still available at 130 deg. F.

Many heat balance applications have been developed to the condition where 80 per cent or more of the heat in the fuel has been put to useful work. Some time ago a plant was developed wherein an engine would supply not only power, but steam heat, hot water and distilled water. One engine developing 235 hp. (¾ load) would supply heat for 530 sq. ft. of radiation at 10 lb. pressure; or, distill 336 gal. per da. of brackish water; or, heat 4800 gal. per da. of 60 deg. F. filtered water to 140 deg. F. for domestic purposes. These operations could be carried out singly or to a lesser degree in parallel.

In Metropolitan Districts

Diesel engines are used in one of the largest department stores in New York City as shown by Fig. 5. Here every effort was made to recover the heat ordinarily wasted. Air heaters were installed to take practically all of the recoverable heat from the jacket water and exhaust heat boilers were installed to recover the heat from the exhaust gas. A simplified flow diagram of this system is shown in Fig. 3. It will be seen that water for the building is taken from the city mains and put through the engine and then to a surge tank from which one line runs to air heaters and the other to the exhaust heat boilers. A third connection is made from the surge tank from which the excess hot water is pumped through a heat exchanger back to the engine where regulating valves blend it with the incoming city water. Cooling water for the heat exchanger is taken from a supply well and is returned to a diffusion well.

Water is pumped from the surge tank to the exhaust heat boiler out of which it passes to a 2000 gal. tank mounted on the roof or to a 1000 gal. tank in the building. Thermostat controls are provided on the feed water pump in order to control its operation in relation to a recirculating pump so that the entire mass of water may be heated before fresh water is admitted to the exhaust heat boiler.

The development of heat balance applications has only recently received the attention it deserves. This condition is in part attributable to a poor start resulting from a statement in Diesel's original treatise. At that time the theoretical efficiency of the Diesel engine was so far in advance of existing commercial steam equipment that he stated, "if the heat in the jacket water be utilized to produce steam . . . . the advantages are too small to compensate for the rather complicated mechanism required." Since that time the mechanism has been found to be comparatively simple, requiring only an appreciation of certain natural limitations.

Sub-station Improvement for Colorado Company

At the company's Boulder sub-station, the Public Service Co. of Colorado has launched a $60,000 improvement program. Two aims enter into the work-reduction of hazards for employes at the sub-station and beautification of the structure and its surroundings. The immediate objective is increasing the capacity of the sub-station from 2500 to 4500 kv-a. The project is under the general direction of Lloyd S. James, chief electrician for the northern division.

One of the first tasks, now completed, was the construction of two large concrete bases adjacent to the building on the east for an outdoor sub-station. On one of them will be a new 3000 kv-a. transformer, weighing 24 tons. On the other foundation will be a bank of three transformers of 500 kv-a. each, now located inside the sub-station. A 1000 kv-a. bank of three transformers, also in service inside, will be moved to some other sub-station in the state.

Moving the transformers outdoors is one of the safety features. Another will be the installation of new switchboards, including feeder switches, bus work, panels and circuit breakers.

With the removal of the transformers gas heat will be installed in the building. The old equipment will be replaced because of its obsolescence.

Standard Sizes of Radiators

Unanimous approval by all manufacturers of cast-iron radiation has been given to a program which will make effective a reduction of almost 50 per cent in the number of sizes of cast-iron radiators. This program has been developed and sponsored by the Institute of Boiler & Radiator Manufacturers and all manufacturers of cast-iron radiators have signified their intention to produce only the sizes which have been adopted as standard by the Institute. Large tube radiation will be produced in 17 sizes instead of in 30 sizes as heretofore. Small tube radiation, which heretofore has been made in 17 sizes, will hereafter be made in 11 standard sizes.

Hotel Reduces Steam Costs

By use of cheap coal, steam is generated at 9 cents per thousand to take place of purchased steam at 57 cents.

By HERB DEVOL

Chief Engineer, Schimmel Hotels

LET ME SAY at the outset that I realize the record of the Custer Hotel, Galesburg, Ill., is in many respects unique, that it can not be duplicated everywhere, but I tell the story here because it illustrates what can be achieved in scores of places, in varying degree, by taking advantage of local opportunities. The many other "near the mine" localities, especially, can profit by following in the Custer's footsteps.

At Galesburg, the outstanding local opportunity was the proximity of "carbon" coal. This coal came from two shaft mines which, not being on a railway, supply a local market by truck. The preparation is such that there is a surplus of $\frac{5}{16}$ in. to 0 in. carbon. This coal has a good heat content, but is so small that firing it was an unsolved difficulty.

One of the mines discovered a means of firing this coal with Iron Fireman Pneumatic Spreaders. The mine's stokers handle the coal with high efficiency—the fine particles burn in suspension; while the larger pieces burn in a shallow layer on the grates, which are pierced only with pin-holes, so that sifting is no problem. We decided to adopt pneumatic spreader firing, and obtained a fuel contract at a price of $0.98 per ton, delivered, including tax. This price gives us approximately 210,000 B.t.u. per cent.

The boiler plant modernization was made at the same time that the hotel was expanded, with the addition of 56 guest rooms, new ballroom, lounge and other facilities.

The stack is steel, 38 in. by 100 ft., set outside the boiler room with a horizontal run of breeching from the boilers. The plant requires about 20 per cent make-up water. City water, which is from deep wells and contains from 20 to 28 grains of hardness, is used. The make-up water is softened by a Lakeside zeolite softener. The boiler feed pump is manufactured by the Fairbanks-Morse Co., and is complete with receiving tank and float automatic control. An American Marsh vacuum pump is used for pumping returns in place of the previous gravity system. An outstanding feature is that all piping for hot and cold water is of copper with soldered joints, thus avoiding the corrosion which within a few years attacks steel pipe.

Our two Murray Iron Works 66 in. by 16 ft. h.r.t. boilers operate at 150 lb. By adopting pneumatic spreader firing we were able to fire both boilers from one stoker. This minimized the stoker investment, and yet both boilers are stokered. The boilers and stoker were set in accordance with the manufacturer's recommendations as shown in the accompanying drawing. Note the location and arrangement of the under-grate fans between the boilers, to conserve floor space.

Fig. 1. Firing aisle in Custer Hotel plant shows arrangement whereby one stoker may serve either of two boilers

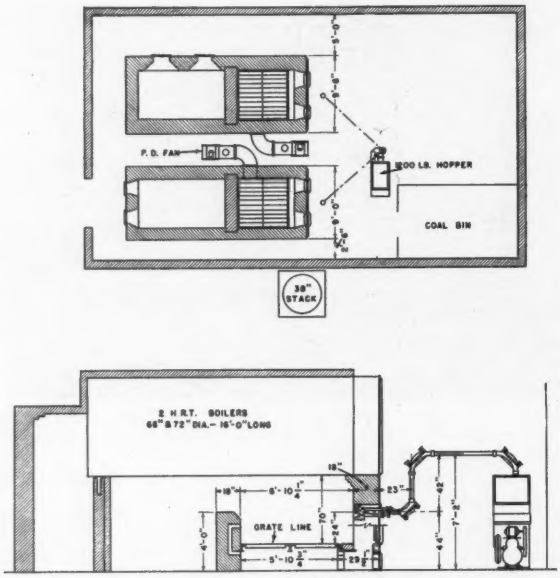


Fig. 2. Plan and elevation of boiler setting and stoker arrangement

The essential proportions are:

Effective grate area	35 sq. ft.
Furnace volume	250 cu. ft.
Combustion volume	530 cu. ft.

Prior to the installations of the new boilers and stoker, all low-pressure steam had been purchased from the city heating plant. The average cost was 57.9 cents per thousand pounds. During the 1937-38 season the total purchased steam was 3859 thousand pounds, at a cost of $2234. The 56 room addition increased the heating load by one-third, so that the adjusted heating bill is computed at 4145 thousand pounds, in the amount of $2877. Had purchased steam been used for all heating, and the old boiler plant been continued for high-pressure steam, I estimate the cost at $4000.

The actual operating records of the new boilers and stoker, firing the "carbon" coal, show a steam cost per thousand pounds of only 9.1 cents. Thus the present fuel bill is only 16 per cent of the cost of purchased steam. And the total new fuel bill, including high-pressure steam for laundry and cooking, is only 25 per cent of the estimated cost for the increased load under the old conditions. Our present coal bill is less than $1000 annually.

In addition to this economy, other important benefits have been obtained. Formerly, steam pressure used to drop rapidly, to the discomfort of our guests. The new boiler plant keeps steam pressure constant. Water pressure formerly fluctuated excessively. The new plant includes a booster pump. Now there is ample steam and pressure for expediting the work in the laundry.

The plant has been so arranged that there is ample space for installing equipment at a later date for generating current. The load has been carefully studied, and we have found that there will be a good heat balance at the designed and operating pressures.

Coal Price Hearings End

FINAL HEARING for the establishment of minimum prices "at the mine" for bituminous coal throughout the United States has now been finished by the Bituminous Coal Division of the Department of Interior. This completes a major step in the establishment of minimum prices and marketing rules for stabilizing the bituminous coal industry under the Bituminous Coal Act. The next step will be the publication of final price schedules recommended by the Division Trial Examiners who conducted the hearing, which will follow the hearing of arguments and the filing of briefs by persons who participated in the hearing. This will leave only the hearing of exceptions and appeals before the process is completed.

This report, which will contain schedules of what the Examiners think the prices should be in light of the testimony in the hearing, will be made public, according to official announcement, in ample time to permit the filing of exceptions with the Director.

Minimum prices will cover substantially all of the commercial coal sales in the United States. They will be quotations at the mine mouth, loaded on transportation facilities, and not delivered prices. They will not apply to sales by retailers, and will be only the minimum amounts at which the coal may be sold.

The established prices will reflect the joint work of several hundred of the industry's elected and appointed representatives, individual coal companies, coal consumers and their representatives, the Consumers' Counsel Division of the Office of the Solicitor, Department of Interior, and the Bituminous Coal Division.

Schedules will include prices for each specific size and grade of coal produced by each of the country's more than 13,000 bituminous coal mines whose operators have joined the Coal Code to bring their businesses into the market stabilization plan provided by the Bituminous Coal Act. The schedules will be grouped regionally.

Testimony and exhibits introduced at the hearing cover such matters as the geographical boundaries of market areas which may constitute common consuming market areas for coals from different districts; transportation methods and charges; location of rail-connected mines by groups arranged according to the freight rates applicable to the mines; freight rates applicable from each rail-connected mine to destination points, involving 22 production districts and more than one million freight rates; analytical study to determine the average chemical analytical value of coals produced in the respective districts on a seam, quality and prepared size basis; analytical study of the chemical and physical characteristics on a basis of how much heat is capable of being extracted from coals; the history and movement of the price of railroad locomotive fuel, including both fuel produced and consumed on the railway serving the mine, and coal sold to railroads off the line on which the coal originated.

Eliminating Underground Corrosion

By C. W. GEIGER

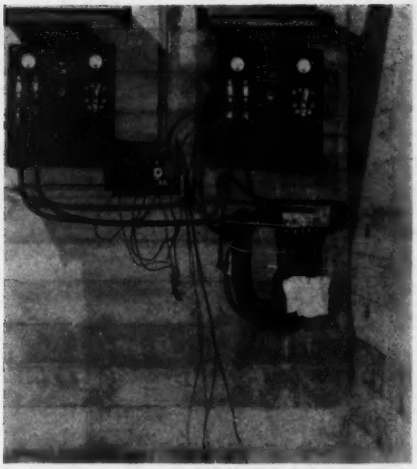


Fig. 1. An installation of corrosion eliminators at Treasure Island

WHEN THE UNDERGROUND pipe failures on Treasure Island appeared to be getting out of control, an elaborate system of cathodic corrosion eliminators was installed by the exposition company in cooperation with engineers of Electrical Facilities, Inc., of Oakland and of the Pacific Gas and Electric Co., the latter a pioneer in cathodic protection.

Some 10 yr. ago the P. G. & E. Co. worked out a system of electrical pipe protection which was applied to the main natural gas line near San Francisco where severe electrolytic corrosion was encountered. It has been estimated that the electrical protection system installed on that line has saved the company approximately $200,000.

The 400-acre tract constituting Treasure Island in San Francisco Bay has proved to be one of the most corrosive spots in the United States insofar as underground pipe and lead covered cable is concerned. The electrical protective measures which were applied to the Exposition network are of particular interest since it shows what can be done on a network having five divisions as follows: 1. Bare pipe. 2. Wrapped pipe. 3. Thin wall pipe. 4. Standard weight, screwed joint and welded pipe. 5. Lead covered electric cable.

All of these lines were installed in a non-homogenous highly corrosive fill, dredged up from San Francisco Bay. So corrosive was this fill that the thin walled No. 16 gage pipes which were calculated to have a life of 10 months, failed in 90 days! The domestic water system was the last network to be installed and was completed April 10, 1938. The first failure occurred on July 22, 1938.

A total of 25,700 ft. of underground natural gas pipe was installed on the island in 1938 for operation at a gas pressure of 10 lb. per sq. in. Shortly before the opening of the Golden Gate Exposition compressed air was impressed on this system for test purposes and to the amazement of the engineers it was found that these lines which had been installed only a few months before could not sustain an air pressure of 10 lb. The gas pipes had failed even before the natural gas was turned into them.

Welding engineers and contractors who examined the system after the failure pointed out that the failure was due to electrolysis. There were some breaks in the system caused by the passage of heavy trucks and tractors but these were relatively few. As a precautionary measure, three miles of the pipe were dug up, removed from the trenches and replaced with a brand new pipe line shortly before the opening of the Exposition. The removed pipe was found to have been greatly damaged by electrolytic corrosion. An engineer of a company which had planned to purchase the damaged pipe for possible use in carrying water on another engineering project found the disintered pipe so badly corroded that he would not purchase it.

When the Exposition officials and engineers realized the seriousness of the electrolytic corrosion situation on the island, a conference was held with the engineering department of the East Bay Municipal District and a plan was suggested by which the approximate current necessary for electrical protection of the underground network could be estimated. At that time it was estimated that 427 amp. of direct current would be required to protect the entire system and 10 8-v., 50 amp. Type C Rexselen cathodic corrosion eliminators were purchased from Electrical Facilities, Inc. Two additional units were installed later, bringing the total capacity of the system up to 570 amp. Since this installation there has been no further evidence of corrosion.

The principles involved in combating electrolytic corrosion by electrical methods are quite easy to understand. Corrosion of pipe is due to electrical currents that flow from the pipe to the soil. These currents may be local and the resulting damage is called local or self-corroded. At other times they may be due to stray railway currents or galvanic currents flowing along the pipe between different types of soil. These currents are called line currents and the destruction caused by them is referred to as electrolysis. These two classes of corrosion require the same type of mitigated measures to protect the pipe against the action of the stray or locally induced currents, a compensating current must be caused to enter the pipe at one

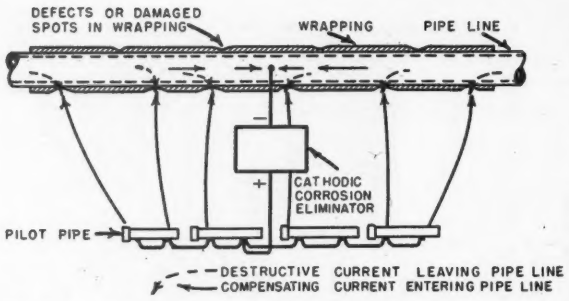


Fig. 2. Diagram showing the principle of cathodic corrosion control

or more points. This is accomplished by connecting a cathodic corrosion eliminator as shown in the accompanying diagram.

The positive terminal is connected to the pilot pipe or auxiliary electrode and the negative terminal to the pipe to be protected. The compensating currents from the cathodic corrosion eliminator shown by the full lines in the above diagram pass from the pilot pipes into the soil, entering the pipes at various points throughout the line. At these points they neutralize the destructive currents shown by the dotted lines. With proper adjustment of the cathodic corrosion eliminator all corrosion is transferred to the pilot pipe which is proportioned to have a useful life of 30 or more years.

The ground electrodes at Treasure Island are two types, vertical, second hand steel pipes and horizontal steel pipes placed in trenches. The pipes are each 25 ft. in length, 9 or 10 in. in diameter. The vertical pipes were installed in holes drilled to a depth of 26 ft. by means of two hand operated well drilling rings. The ground bed at Station No. 1 which was installed near the easterly shore of Treasure Island consisted of 21 vertical 5 in. pipes, 20 ft. in length and spaced 10 ft. apart, the lower portion of these pipes are in salt water. In this case the lower end of the ground electrodes and pilot pipes discharge practically all of the current but the maximum corrosion on a vertical steel electrode generally takes place in the capillary fringe a few feet above the water table. The rapidity of corrosion at this point usually cuts off the more active portion of the electrode within a year or two, although there may be still sufficient metal below the capillary fringe for many years of service.

In order to avoid the possibility of this loss of active electrode surface, a gray bar rubber covered copper 19-wire cable from the corrosion eliminator was placed inside of each pipe and welded to the internal surface at several points along its length as shown in the accompanying photograph.

The expenditure for proper pipe and cable protection at Treasure Island is well justified. Underground lines are essentially service structures and to afford the desired financial return must maintain continuity of service. The first electric protection units at Treasure Island were placed in operation at Station No. 1 on September 12, 1938, at which time leaks had already begun to develop at an alarming rate on the domestic water pipe system. Since its installation, however, there has been practically no further evidence of leakage.

Fig. 3. Copper wire leads to pilot pipe buried in the soil. These leads later were connected to the positive terminal of the cathodic eliminators

Don't Hurry Water

By GEORGE P. PEARSE

OVER A YEAR AGO Joe, the engineer, had suggested to the manager that the company buy the old Wycroft farm to use as a testing ground and had pointed out that there was a large lake on the farm from which they could obtain the 112,000 gal. of water per day required by the general plant. In this way they could obtain their water supply at the bare cost of pumping which would be a great saving over the cost of purchased water and in time would pay for the farm. The manager thought the idea was good and so the purchase was made.

In the months that followed Joe was greatly disappointed at not being asked to take over the design of the new water supply system and he could not understand why until the day the manager hired his brother-in-law, a Mr. Fritz, to make a study of the problem, prepare the drawings and write the specification. After this there followed 3 mo. of mysterious activity, then the manager sent for Joe and handed him a blue print and some typewritten papers and said: "Here's the plan and specification for the new water supply system. Now go ahead and order the materials and get the job done—it's 'way behind schedule now."

Joe quickly glanced over the drawings, first curiously and then in amazement. "Say!" he gulped. "Do we have to use a 40 hp. centrifugal pumping unit to get that water over to the plant?"

The manager did not like Joe's outspoken ways

so the answer was rather gruff: "That's just the difference between guessing and a thorough investigation," he snapped. "Mr. Fritz told me, just before he left, that he had figured out five different schemes before deciding on this one and that this was unquestionably the most practical, efficient and economical of them all. According to this plan you start the pump every morning at seven, and shut it down every evening at four; you will also shut it down during the noon hour unless there should be an excessive demand for water. During eight working hours the pump will deliver 112,000 gal. of water which will meet our daily requirement. A study of our demand shows that 90,000 gal. are used in the eight working hours and 22,000 gal. during the other 16 hr. To provide for the off working hours' load and also to balance the maximum and minimum flow Mr. Fritz has specified that a 45,000 gal. storage tank be placed on the roof of the warehouse to take care of all emergencies. This arrangement will provide 23,000 gal. of dead storage and would enable the plant to start operations every morning even if there should happen to be pump trouble. Everything all clear to you?"

"Somehow it still seems to me that the pump is entirely too big; anyway, I'm going to check up those figures," answered Joe.

"That's okay; go ahead. If you can think of anything better I'll be glad to hear about it," agreed the manager with a well satisfied smile.

A couple of hours later the office boy delivered Joe's requisition for the pumping equipment to the manager and two seconds after he had read it he buzzed for the engineer.

Joe entered the private office again and before he was even inside the manager barked: "Say! What's the idea of ordering a 5 hp. pumping unit when Mr. Fritz's calculations show that a 40 hp. unit is the smallest that can be used?"

"Listen! Your man Fritz might be good at calculations but he's no engineer. There's no sense in buying a 40 hp. unit when a 5 hp. one will do the work. You hired me to save money—not to spend it," explained Joe belligerently.

"But," snapped the manager. "Mr. Fritz assured me he was using conservative figures: For instance the water velocity through the 4-in. pipe line is below 6 ft. per second," then the manager gave a little smile. "By the bye, you haven't overlooked the 90 ft. difference in level between lake and storage tank—have you?"

"No, I haven't," answered Joe decidedly, "but there are a few things that Fritz overlooked. For one thing nothing is gained by running the centrifugal pump only 8 hr. a day. That would unnecessarily increase your demand load and electric power rate and, in addition, there would be the bother of priming and starting the pump every morning. Remember also that pump is over a mile from the plant; 5400 ft. from the storage tank to the water intake to be exact. Don't your realize it is better to leave it running at full power most of the time and thus create a smooth constant electric load which would improve your 'demand to average' ratio and result in a lower power cost, a better power factor and a lower operating and maintenance cost?"

"But your statements don't make sense," insisted the manager. "Even if you do run the motor three times as long per day you will still need at least ⅓ the power and that would take a 15 hp. motor, whereas, you ask for only 5 hp. which is ⅛ of the 40 calculated by Mr. Fritz. It takes the same horsepower hours to put the same quantity of water in the tank whether you do it in 8 hr. or 24, doesn't it?" queried the somewhat bewildered manager.

"No, it doesn't," answered Joe frankly. "When you try to hurry water through a pipe it puts up a stiff fight. Fritz figured out a velocity of 5.9 ft. per sec. through a 4 in. delivery main and that makes a pressure loss of 16.2 lb. per sq. in. for every 1000 ft. which for 5400 ft. amounts to 87.5 lb. per sq. in. at the pump and on top of this there is the 39 lb. necessary to lift the water 90 ft. up into the storage tank, so the 40 hp. pump would have to be operated against 126.5 lb. Now I have dropped the velocity to just under 2 ft. per sec. which reduces the loss of pressure per thousand feet to only 2.12 lb. or 11.43 lb. for the 5400 ft. The energy required to lift the water up to the tank is the same but the total pressure against the pump is reduced to a total of only 50.43 lb. per sq. in. which at 50 per cent pump efficiency is just under 5 hp. I had to increase the size of the storage tank to 60,000 gal., since the consumption during the eight working hours is about 6500 gal. per hr. more than the pump is supplying and the difference must be made up from storage. Of course during the 16 hr. of minimum demand of less than 1400 gal. per hr. there is ample time for the pump to catch-up."

"Guess I was rather stupid in not letting you handle this design from the beginning," admitted the manager meditatively.

"Yes, you were," snapped Joe who always spoke very frankly.

England to Pipe Coal in Gas Form

A MODEL gas grid in Yorkshire, England, sponsored by the United Kingdom Gas Corp., is the forerunner of networks of pipe lines which will help to make British industry independent of imported fuel supplies and is now nearing completion.

By means of the grid, pure coal gas will be pumped direct from pethead (mine) plants at "key" points to strategically placed gas undertakings for distribution to industrial and other consumers.

More than 55 miles of trunk lines have been put down at a cost of $25,000 per mile. The grid will supply more than 6,799,000 cu. ft. of gas daily from the great coke-oven plant, one of the largest of its kind in the world, consuming 4000 tons of coal a week.

BY the use of Cone worms of nickel-chromium-molybdenum, steel with nickel bronze worm wheels, Timken nickel alloy steel roller bearings and nickel cast iron housings, Michigan Tool Co. has reduced the size of heavy duty speed reducers by ⅓, giving lighter weight and greater flexibility in application.

At the World Automotive Engineering Congress of the S.A.E. last summer the author covered the full range of modern engine bearings from design to maintenance. This abstract of the paper is confined largely to the maintenance problem as encountered by the operators with only a bare outline of the design problem considered necessary to supply a background of the why and wherefore of maintenance.

ENGINE BEARINGS— Design and Maintenance

By ALBERT B. WALLI
Chief Engineer
Federal-Mogul Corp.
Detroit, Mich.

IN ATTEMPTING to set up standards for predicting the life expectancy of the main and connecting rod bearings in any given engine, a great many things must be considered. When a bearing fails in the field, the reason is most frequently attributed to one of three good old standard causes: poor babbitt, faulty bond or inferior oil, so the failures are blamed on the shortcomings of the bearing manufacturer and the oil producer. There are some others, however, who are also very deeply involved in these things, and six major causes of bearing troubles, failures and dissatisfaction can be catalogued as shown in Table I.

For engine bearing linings, four general types of alloys, or compositions, are commonly used: tin-base babbitts, which are applied to either steel or bronze backs; high-lead babbitts, which are applied to either steel or bronze backs; cadmium alloys—such as cadmium silver and cadmium-nickel, which are applied to steel backs only; and copper-lead mixtures, which are applied to steel backs only.

None of these compositions can be considered a universal bearing material, suitable for use in any and all installations. Each has its own particular field of usefulness and set of conditions, under which best results are obtained. Table II defines the field of usefulness for five types of bearing metals.

Table I. Six major causes of bearing failures

MAJOR CAUSES OF BEARING FAILURES
1. Faulty design or too much engineering compromise both in the bearings themselves or in associated parts of the engine.
2. The existing practice of procuring engine bearings competitively with the prices based on incomplete specifications.
3. Mis-use and abuse in operation and maintenance.
4. Faulty installation mainly in service bearings replaced in the field.
5. Inferior lubricants or good lubricants improperly prescribed and used.
6. Faults of material and workmanship in the bearings themselves and in associated parts of the engine.

The foundation of any bearing is its back structure. With the advent of the very thin steel back bearings, it became noticeable that in many cases, areas of failure developed closely adjacent to the parting faces rather than in the higher loaded areas of the bearing. Also that bearings of this character tend to lose their spread after a relatively short period of operation because the "rolling mill" action of the rotating crankshaft has an effect such that the crush is lost and the open ends of the bearing tend to close in and hug the shaft. A contributing cause appears to be the stresses set up by differential contraction between the babbitt and the thin steel shell during solidification after pouring, and differential expansion during operation. It is believed

Table II. Field of usefulness of various bearing metals. The first three metals are not affected by corrosion and the last two are not likely to if proper oil temperature and recommended lubricant is used

BEARING METAL	MAXIMUM UNIT PRESSURE, PSI	OIL RESERVOIR DEG. F.	SHAFT HARDNESS
TIN BASE BABBITT Copper .....3.50% Antimony .....7.50% Tin .....89.00% Lead (max).....0.25%	1000	235	Not Important
TIN BASE BABBITT Same composition as above	1500	235	Not Important
HIGH LEAD BABBITT Tin ..... 5 to 7% Antimony ....9 to 11% Lead .....82 to 86% Copper (max)....0.25%	1800	225	Not Important
CADMIUM-SILVER Silver .....0.75% Copper .....0.50% Cadmium 98.75%	1800 to 3850	260	250 Brinell
COPPER-LEAD Copper .....60% Lead 40%	Over 1800	260	300 Brinell

that the strength and stiffness of the bearing structure must be sufficient to resist both the "rolling-in" action, and the effect of differential contraction and expansion. Definite improvement in bearing performance has been obtained when excessively thin steel backs have been increased.

Oil Flow

Certain high speed engines have been examined whose record of connecting rod bearing performance was not so good, even though the various factors, so far described, indicated that it should be. One cause of this inferior performance seems to be tied in with insufficient lubrication, which is indicated by investigation of the factors governing the flow of oil from the main bearings, through the drilled oilway in the crankshaft to the rod bearings.

This is illustrated by conditions governing the flow of oil to the rod bearings in one engine. The oil gage pressure in this engine was 45 lb. and with an indicated back pressure at the surface of the journal of 8 lb., giving an effective theoretical "IN" pressure of 37 lb. The calculated centrifugal pressure at the surface of the crankpin "OUT" is 63 lb., which is 26 lb. greater than the "IN" pressure, so the conclusion is drawn that the oil can be thrown out of the bearing faster than the pump can force it in.

The potential life expectancy of connecting rod bearings may also be reduced by restrictions in the main bearing oil feed grooves. From observation of many engines, we have established the standard for our own work that the cross sectional area of a complete internal annular main bearing feed groove shall bear the ratio of 1 to 4 with the area of the crankshaft oilway to the crankpin.

The function of oil in a bearing is two fold—to lubricate and to cool, and one is probably just as important as the other. If oil is to serve efficiently as a coolant, it must circulate and this requires adequate space or clearance to flow through. Obviously, in the matter of oil flow through the bearings, it is sometimes necessary to compromise in order to favor other elements in the engine, but it must be kept in mind that inadequate oil clearance will surely result in reduced bearing life. This is illustrated by a typical bearing originally assembled on a 4 in. diameter shaft with 0.0015 in. oil clearance. Its life was too short but with 0.004 in. clearance, satisfactory performance was obtained.

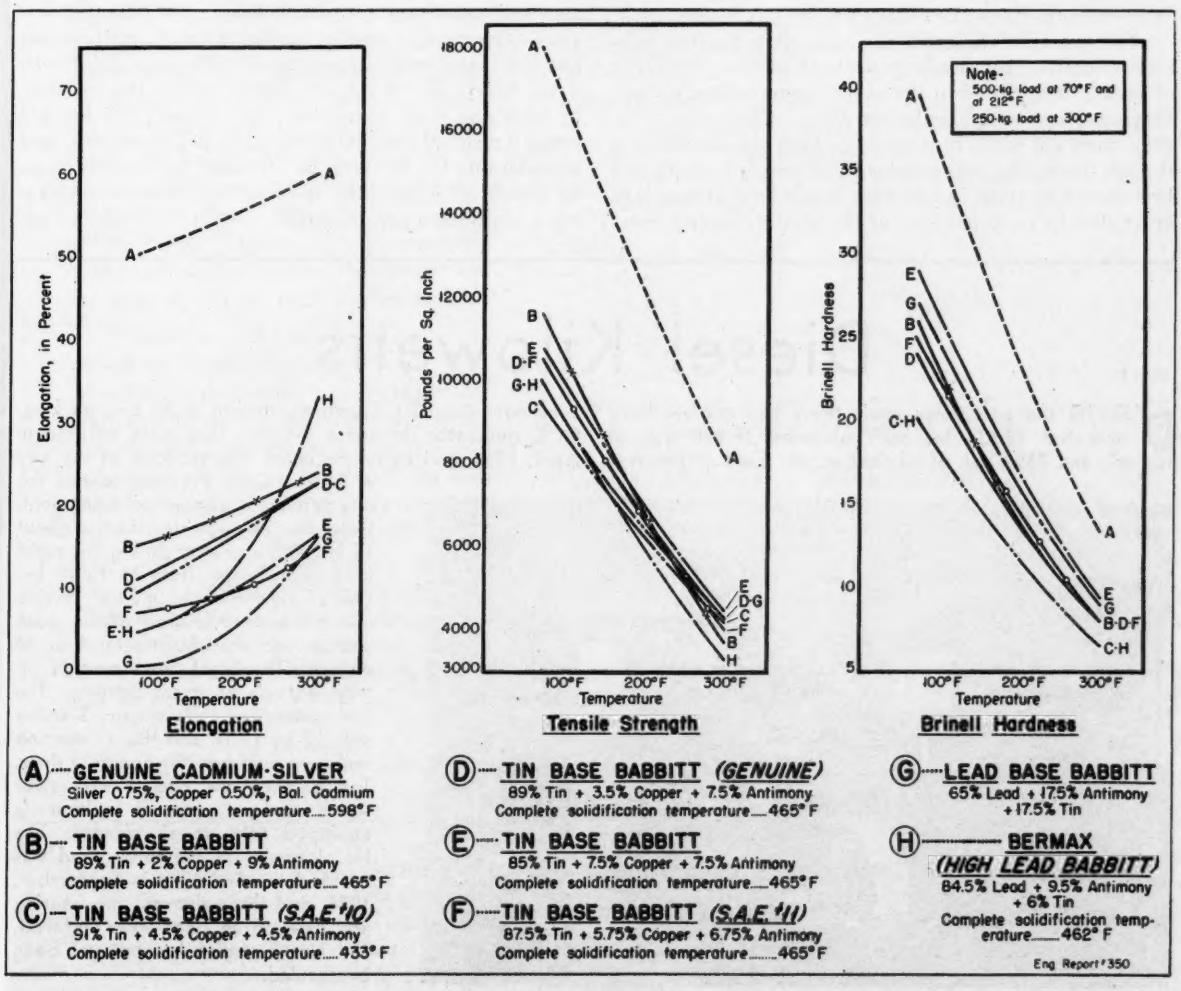

Elongation, in Percent
Temperature
100°F
200°F
300°F
Elongation
Pounds per Sq. Inch
Tensile Strength
Brinell Hardness
Note-
500-kg. load at 70°F and at 212°F
250-kg. load at 300°F
Brinell Hardness
(A) GENUINE CADMIUM-SILVER
Silver 0.75%, Copper 0.50%, Bal. Cadmium
Complete solidification temperature....598°F
(B) TIN BASE BABBITT
89% Tin + 2% Copper + 9% Antimony
Complete solidification temperature....465°F
(C) TIN BASE BABBITT (S.A.E. #10)
91% Tin + 4.5% Copper + 4.5% Antimony
Complete solidification temperature....433°F
(D) TIN BASE BABBITT (GENUINE)
89% Tin + 3.5% Copper + 7.5% Antimony
Complete solidification temperature....465°F
(E) TIN BASE BABBITT
85% Tin + 7.5% Copper + 7.5% Antimony
Complete solidification temperature....465°F
(F) TIN BASE BABBITT (S.A.E. #11)
87.5% Tin + 5.75% Copper + 6.75% Antimony
Complete solidification temperature....465°F
(G) LEAD BASE BABBITT
65% Lead + 17.5% Antimony + 17.5% Tin
(H) BERMAX
(HIGH LEAD BABBITT)
84.5% Lead + 9.5% Antimony + 6% Tin
Complete solidification temperature....462°F
Eng. Report #350

Fig. 1. Physical properties of alloys used as bearing linings, test specimens cast with normal cooling

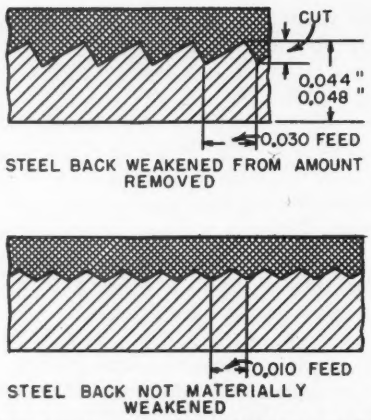


Fig. 2. Sections through typical shell (left) bored with 0.030 in. feed and (right) with 0.010 in. feed. The sharp points against which the babbitt lining is hammered serve as starting points for fatigue cracks. While these points are still present with the smaller feed they are more numerous and the unit pressure is lower

It has frequently happened that standard quality babbitt bearings have proven unsatisfactory; the possibilities of improvement by change in processing methods with a moderate cost increase have not been explored and a shift made to a more expensive type of bearing material. Aside from the questionable economy involved, sometimes the results are disappointing.

For example, the condition of certain tin-base babbitt connecting rod bearings made to highest standards of quality and tested in the same engine with alternate bearings lined with a cadmium alloy. The latter, however, were not made to these same high standards, even though their price was greater. The areas of cracks and broken out sections in the high grade babbitt bearings amounted to 11.00 per cent of the total developed bearing area. The cadmium alloy bearings were broken up to the extent of 34.53 per cent and in addition were corroded to the point of complete failure.

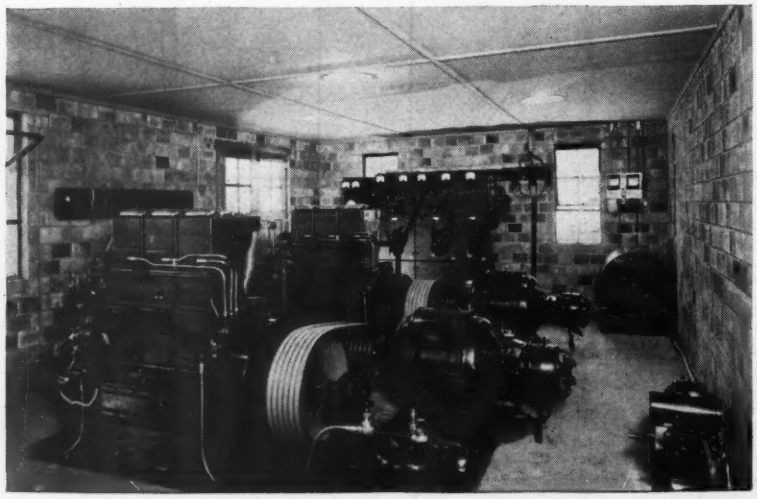
It is only fair to state that the cadmium alloy bearings were manufactured by methods intended to provide lowest cost and in addition the alloy was found to be excessively high in tin—an element which is poison to cadmium. Nevertheless, they must be considered typical of bearings which are being supplied to the trade. Attention must be paid to detail in the specifications to which engine bearings are purchased so as to include certain of these points of manufacture and thus obtain some control of both quality and price.

Faulty Installation

Matters of design, selection of materials, methods of bearing manufacture and procurement of specifications as discussed, are quite within the control of the engine builder, but his careful calculations and good intentions are easily defeated by failures in service bearings replaced in the field. Specific reasons for failure, as determined by investigation are: inadequate oil clearance; dirt particles between the back of the bearing and its seat in the rod or crankcase; foreign particles imbedded in the bearing lining; out-of-round connecting rod bores; out-of-round crankshaft journals and crankpins; sprung crankshafts; a detonating engine; oilways and suction screen clogged; and engine put into hard service immediately after a rebuild with a too heavy oil. A rebuilt engine should theoretically be on a par with a new one, but actually the fits are usually tighter, the refinished parts not so smooth, and considerable benefit is to be obtained by the use of an oil which is lighter than the standard recommendation for a reasonable run-in period.

Diesel Kilowatts

DURING the past three years these two engines have operated 28,572 hr. and consumed 75,588 gal. of fuel oil, and 2697 gal. of lubricating oil. Each engine is a 3 cylinder Model L Cummins, driving a 50 kw., 63 kv-a. G. E. generator through 6 V-belts. They were installed in April, 1936, and carry the entire electric load of the city of Lyons, Colo. Previous to this the city purchased power from Longmont, Colo. The average day load is about 15 kw. with a peak of 40 kw. The night load peak ranges from 65 to 70 kw. One of the engines is on 24-hr. service and the second is used during peak periods and shut down after 9 or 10 o'clock. The night load consists almost entirely of street lighting. The two generating units occupy a space only 12 by 12 ft. and the air starting tanks are built into the concrete floor. The engines are cooled with river water and at present neither is equipped with an air cleaner. The No. 1 engine in the foreground was checked the first time in September, 1938, and three sleeves, one bearing and new piston rings were installed. The No. 2 engine has not yet been overhauled.



The PRACTICAL ENGINEER and ELECTRICIAN

R. H. MORRIS, EDITOR

Should He Have A Name?

Over a period of eight months our nameless Hero has acquired a following of several hundred helpers who puzzle through his problems and share his trials and tribulations. The judges out in the back room combing the knots out of their whiskers after settling the prize awards on Problem 6 seemed to feel that the poor fellow should have a name. Unfortunately, however, the judges' contemporaries do not agree and the argument has reached such proportions that civil war is imminent. With all the wisdom of a Solomon the Editor passed the buck to the readers and all have agreed to abide by the decision.

Should the poor fellow be named or should he remain simply our Hero? If he should be named, what is your suggestion? This is a vote, not a contest, and if the "Name Him's" win the most suitable names submitted will be published and the best selected by popular vote. We are fresh out of leather medals and furlined shaving mugs but the reader submitting the winning name will receive a copy of the book Combustion Control Specifications which sells for $1.00. If the same name is submitted by more than one, duplicate awards will be made.

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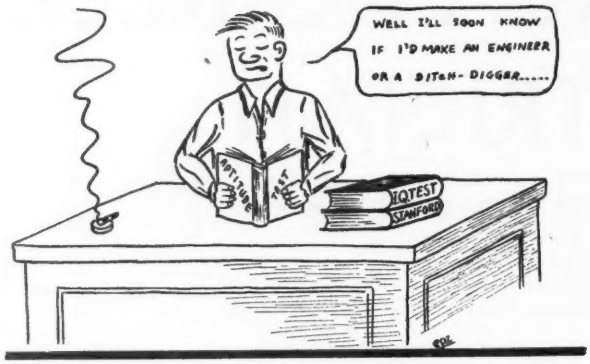


The Right Job

SOME MEN ARE ENGINEERS, others butchers, bakers, lawyers, doctors, dentists, etc., on through every walk of life. Circumstances play an important part in this but over a period of years the majority will gravitate, if not to the job they like best, to something they can do sufficiently well to provide a living and enable them to do what they like best on the side as a hobby or avocation.

Most people like best what they can do best and the ease with which one person can do a thing almost impossible for another even after successive trials indicates that certain mental and physical traits or abilities are inherited and not acquired. It is common to speak of a great actor, artist, musician or prize fighter as "being born, not made." This may not be only a half truth but it is sufficient to show that the general public recognizes that training is only part of the picture and an outstanding artist can be made only when nature has provided the proper foundation.

One may envy the histrionics of a Barrymore, the perfection of a Sargent, or, the speed and power of a Joe Louis, but, few have the inward conviction that, given the same training and environment, they could do as well. Unfortunately the opportunities for individual accomplishment is not as great in the engineering field yet we have Maxims, Hammonds and Edisons and at the other extreme those individuals who instinctively handle tools and machines the wrong way, men who would never make even passable engineers regardless of training.

Psychologists have long attempted to measure these traits and the result is the well known, but not always well regarded, I-Q tests. While influenced by training and experience, these tests are primarily a measurement of inherited characteristics and abilities. On the other hand the Stanford tests, so widely used in schools throughout the country, are primarily a test of acquired knowledge.

While both of these tests probably well serve the needs of the special group by whom they were originally devised, they are not seriously regarded by the practical man or the business world. The reason lies in the lack of correlation of test results and every day life. That is a test or measurement must not only be accurate or reliable but it must have some significance or validity.

Thus a voltage test or measurement has a high degree of reliability yet in connection with the output or performance of an electric motor it has no validity—it is not a significant measure of performance. On the other hand, a voltage test on a standard light bulb has a high degree of validity for the light output is a significant function of voltage. Before dismissing the I-Q test as irrelevant, however, it is well to consider the remarks made by Guy W. Wadsworth, Jr., personnel manager of the Southern California Gas Co., at the Los Angeles meeting of the A.S.M.E. He said:

"Where . . . intelligence-test standing of employees already on the pay roll has been compared with success on the job . . . several important relationships have been discovered which may profitably be observed in hiring new employees. The first and most common finding . . . is . . . striking similarities in the mental-ability scores of employees engaged in the same line of work. In a number of occupations, scores are so closely clustered as to indicate both high and low limits in the range of selection."

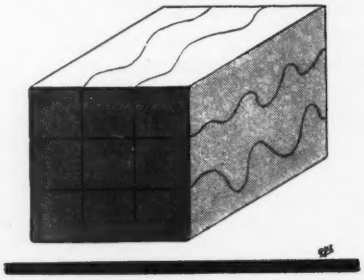


Fig. 1. The wiggly block—the time required to fit the nine irregular sections together is a measure of engineering skill or structural visualization. Most engineers, draftsmen and machinists can do it in less than 4 min., a few in less than a minute. Half of humanity requires more than 4 min., some fail to get it together in a 15 or 20 min. test. Women are slower than men

This may seem analogous to selecting men for different branches of the army in accordance with the physical measurements of present incumbents, yet the fact that certain groups of workers do come within a definite range of test limits is significant. It is also significant that almost a score of companies who make an attempt at proper placement of employees continue to expand these activities.

For the man who must make a living and prefers to do it in an occupation which he will fit naturally, however, that of Johnson O'Connor is outstanding. Dealing largely with engineers and engineering, his work has not received the attention it deserves from the general run of professional psychologists and educators but is being closely followed by an ever increasing army of engineers. Perhaps this is because he himself is, or rather was, an engineer, one of the close knit practical fraternity who look with suspicion on obtuse, theoretical reasoning and feel that a proper approach can be made to a problem only from a firm foundation with both feet on the ground.

Certainly his approach was practical; it was also unostentatious with no indication of where it would eventually lead. After the war, while working at the General Electric Co. as an electrical engineer he became interested in the development of tests to assist in the selection of girls possessing a natural aptitude or ability for small meter assembly work, which requires a high degree of manual dexterity. Test results were so promising that the work was gradually expanded and, in that environment, it was both logical and natural that an attempt was soon made to isolate and measure the particular characteristic or trait that distinguishes engineers from those engaged in other occupations.

Measurement of mechanical or engineering aptitude was eventually accomplished. Before 1930, after eight

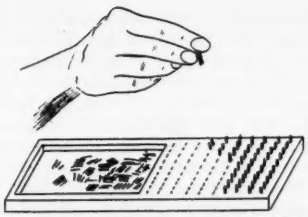


Fig. 2. The punch board—the time required to place 300 pegs, three at a time in 100 holes, is a measure of finger dexterity. Time required ranges from 6 to 12 min. Most of those who prove successful at rapid delicate factory work can do it in 7.5 min. or less. Women are faster than men

years' work, it was possible to test and give ratings of A, B, C and D indicating probable success in engineering. Out of those receiving grade A, 70 per cent became successful engineers; grade B, 30; grade C, 10; and grade D, 2. Test results are thus not absolute but are statistically applicable to the same extent as life expectancy tables. Knowing your age, an insurance man cannot tell you how long you will live but can tell you your chance of living a given number of years. In the same way, test results can tell a student his probable chance of becoming a successful engineer.

The work was extended to the measurement of other aptitudes and occupations. Over a period of years he and his associates have isolated and measured ten aptitudes; identified several others and feel that the total may approximate the number of chemical elements, that is almost 100. These aptitudes put together in different proportions and combinations determine the properties or ability of an individual just as the proportion and combinations of chemical elements determine the properties of matter.

The ten so far measured are: engineering; tweezer dexterity; finger dexterity; accounting personality; tonal memory; visual memory; observation; reasoning; and imagination. In a somewhat different classification is vocabulary, bearing no decided relation to any of the above ten aptitudes, and probably a combination of a natural flair for words combined with conscious or unconscious training. A large vocabulary seems to be a characteristic of the leading figures in every walk of life. It is particularly pronounced in executives, executives in this case meaning anyone in charge of others.

Vocabulary

Oddly enough, vocabulary seems to bear no necessary connection to formal or school education and a group of typical non-college graduate shop foremen average about the same as college graduates, approximately 27 misses out of a 150 word test. One of the highest scores, 2 misses out of the list, was made by a major corporation official who left school at the age of 14. Vocabulary increases with each step in the executive ladder and major executives, that is presidents and vice presidents, average slightly higher than college professors, again with no noticeable difference between the so-called practical man and the college graduate.

Engineering aptitude, perhaps the most interesting of all, is a gift for visualizing three dimensional structures. It is a fundamental requirement of success in architecture, engineering, drafting and machine shop work. It is also found in other professions. Surgeons and sculptors possess it in a marked degree, physiciains and artists do not necessarily have it. It is measured by the time required to fit together the sections of a rectangular prism divided into 9 pieces by four irregular saw cuts as shown by Fig. 1.

Engineers Do It Fast

Some individuals can put the sections together in less than 1 min., some have to give it up after trying 15 or 20 min. Most engineers, draftsmen and machinists can do it in less than four minutes while half of humanity requires more than four minutes. It is interesting to note that while one without the natural aptitude to do the assembly quickly can improve with practice, changing the size of the block, creates an entirely new problem and his time increases. Some engineers can be successful in routine work without a high degree of engineering aptitude, just as one without musical talent can learn to play a piano mechanically by note, but without the feeling and expression of one with natural ability.

Musical ability can be measured by tonal memory, a gift for carrying in mind musical themes. One possessing this ability may, however, be handicapped by a low accounting aptitude which makes it difficult to read and follow notes. Accounting ability is a combination of sight plus mental and physical coordination. It is a fundamental requirement to success in accounting, banking, clerical work, typing and stenography and is measured by the time required to compare two parallel columns of figures and check them as the "same" or "different."

Low accounting aptitude is often the cause of poor school work, because the mind is so much quicker than the hand that there is difficulty in getting thoughts down on paper. Practical acceleration of clerical operations can sometimes correct this.

Contrary to popular opinion, the "slow but sure" individual is not so sure. Tests, confirmed by many investigators, show that the faster individuals make fewer mistakes and the remedy in Johnson O'Connor's words is: "A boy must drive his pencil to keep pace with his mind; not, as so often happens, slow down his thinking to his pencil rate."

In the end it is of course the combination and not individual aptitudes which fit one for a particular type of work. These combinations are innumerable, about 300 have been studied. Imagination and engineering aptitude are characteristic of the inventor. Imagination and reasoning are characteristics of writers, reasoning, an ability to recognize relationships, is possessed in a high degree by diagnosticians in medicine, pure scientists and lawyers.

Another aptitude of importance is personality, the two extremes of the scale being: the objective, a good mixer and group worker; and the subjective, the individualist or lone wolf. House to house salesmen as a group are extremely objective; business executives, objective; professional groups such as designing engineers, doctors and lawyers, subjective; and the scientist, laboratory and research worker extremely subjective.

In many occupations where it is necessary to meet and get along with many people an objective personality is an asset. Unfortunately, this is an inherited trait which cannot be consciously changed. It has been found, however, that a large vocabulary does make a subjective personality behave more objectively, perhaps because it gives him a greater confidence.

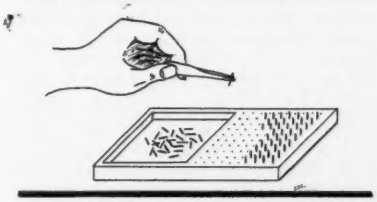


Fig. 3. The tweezers—the time required to put 100 pegs in one hundred holes, one at a time with tweezers, is a measure of dexterity required for clock and fine instrument assembly, machine and hand glass work. Five minutes is fast time; 7.5 min. slow. Contrary to what might be expected this is independent of finger dexterity as measured by Fig. 2, and men are faster than women

Probably the greatest applications of tests of this kind at present is in connection with school work and occupational direction. From the standpoint of the mature individual, however, the value of the O'Connor aptitude tests lies in taking an inventory of natural abilities either to find a more congenial and satisfactory employment where he can make use of his natural mental and physical abilities or to find a satisfactory avocation for his unused abilities. As far as engineering is concerned, an individual need no longer puzzle over whether failure to get ahead is due to the lack of opportunity or the lack of natural ability.

If it proves to be lack of opportunity he can look for another position —if lack of ability he should look for another occupation. Then there is always the younger generation often of more concern to a parent than his own welfare. It is foolish to try and pull a natural born banker into engineering because you like it, or, to push an engineer into banking because you feel he would look better in a white collar and store clothes than in overalls.

R. H. Morris.

So You Want to be a Boiler Inspector?

EDITOR'S NOTE:

From time to time requests come in for information regarding boiler inspectors and their work. These requests are often referred to C. C. Custer, 1012 Michigan Ave., Logansport, Ind., a retired boiler inspector with many years of experience. Of recent months requests for information of this kind have been more numerous and feeling that it may be a matter of somewhat general interest, we have summarized below the more general features of a letter which Mr. Custer wrote to a young engineer in the East not long ago.

There are no books available dealing specifically with this subject but Mr. Custer recommended reading a number of books and magazine articles which he wrote and which appeared in POWER PLANT ENGINEERING *during 1936, 1937 and 1938. The books recommended included the A.S.M.E. Power Boiler Code, published by the American Society of Mechanical Engineers, 29 West 39th St., New York City. The price of the complete edition is $5.50 but the various sections are published separately as follows: 1. Power Boiler Code, $2.50; 2. Suggested Rules for the Care and Operation of Power Boilers, $0.70; 3. Locomotive Boiler Code, $0.55; 4. Low Pressure Heating Boiler Code, $0.65; 5. Miniature Boiler Code, $0.50; 6. Unfired Pressure Vessel Code, $0.75. Many of the states also have laws, rules and regulations covering the construction of boilers and modeled closely after the A.S.M.E. Code. The best known of these are for Pennsylvania, Ohio, Wisconsin and Massachusetts. Residents of each state should familiarize themselves with the state laws. Copies of the Pennsylvania State Boiler Code may be obtained for $1.00 a copy from the Div. of Distribution of Documents, Dept. of Property & Supplies, Harrisburg, Pa. Questions should be addressed to Blaine E. Book, Chief, Boiler Division, Department of Labor and Industry, Commonwealth of Pennsylvania, Harrisburg, Pa. The Ohio Boiler Inspection Law, Rules & Regulations, are printed for the Department of Industrial Relations, Division of Boiler Inspection. C. O. Myers, Chief of Division, reports that the 1936 edition is exhausted and no copies are available for distribution. He refers those interested in the Ohio regulations to the A.S.M.E. Code. Copies of the Massachusetts State Boiler Rules, Form U, Rules for Low Pressure Heating Boilers, Form E, and Laws Relative to the Inspection of Steam Boilers, Form L, may be obtained from the Department of Public Safety, Division of Inspection, 3 Hancock St., Boston, Mass. George C. Parsons is Chief of Inspections. The Wisconsin Code is also out of print at present but closely resembles the A.S.M.E. Code. Questions regarding detailed differences will be answered by M. A. Edgar, Boiler Inspector, Industrial Commission of Wisconsin, 1 W. Wilson St., Madison, Wis.*

Locomotive inspectors come under the Interstate Commerce Commission, Washington, D. C., and the positions are also filled through the civil service competitive system. It is believed that at present a sufficient number of eligibles for present needs will be secured from the existing register and it is not known when another examination will be held. The last examination was held in July, 1936.

The salary of these positions is $4000 a year and the general requirements are: applicant must be a citizen of the United States, must have at least 6 yr. experience with railroads operating as common carriers in addition to the time served in apprenticeship or in attending a technical school. They must be between the ages of 28 and 50 and be in sound physical health. There are also certain preferences because of military or naval services.

Marine boiler inspectors come under the Department of Commerce, Bureau of Inspection and Navigation, Washington, D. C. Duties of the inspectors, together with the rules and regulations regarding boiler plate, boilers and attachments, etc., are included in a book, Form 801A, General Rules and Regulations Prescribed by the Board of Supervising Inspectors which can be obtained free of charge from the Bureau. Rule V, page 147-175, covers licensed officers (engineers, deck and pilots). Inspectors come under civil service and information regarding examinations should be obtained from the U. S. Civil Service Commission, Washington, D. C.

Among the articles recommended from past issues of POWER PLANT ENGINEERING *are the following: Fusible Plugs, p. 300, May, 1936; Remedies for Furnace Explosions, p. 428, July, 1937; Design of Boiler Patches, p. 131, February, 1938; Deterioration of Boiler Sheets, p. 405, June, 1938; Oil and Foreign Substances in Boilers, p. 601, September, 1938; Errors in Reading Water Gages, p. 133, February, 1939; Boiler Accident Records, p. 660, October, 1938.*

Back copies containing these articles are not available but can be found in most public libraries. Photostated copies can be supplied at the following costs per page or fraction of a page: Photostat negatives, white on a black background, 75 cents; photostat positives, black on a white background, $1.50.

Mr. Custer has also compiled a list of several hundred questions which he has selected from examinations in various parts of the country. Mimeographed copies of these are available direct from Mr. Custer at a nominal cost. We cannot undertake to answer questions of this type but Mr. Custer has in several cases made arrangements to read and criticize the answers for a reasonable hourly charge.

Here is Mr. Custer's letter on the qualifications for a boiler inspector outlined by him for readers of POWER PLANT ENGINEERING:

About Qualifying for a Boiler Inspector

By C. C. Custer

A correspondent wants to know something about the qualifications of, and training necessary to become, a boiler inspector. This covers a broad field for there are three kinds of boiler inspectors in the U. S. A.: marine boiler inspectors; Interstate Commerce locomotive boiler inspectors; and the common or garden variety of boiler inspectors who operate only on stationary boilers and whose qualifications must comply with State or Municipal laws if there are any and also meet the requirements of the casualty insurance company for which he works.

Many states require an examination and license to be issued before an inspector can work. A few states merely require that the inspector be an authorized inspector from an insurance company, the inference being that all insurance companies, for their own protection, see to it that their inspectors are properly qualified. In a few states where there are state inspectors who generally hold their office as a political appointment and like all political appointees may or may not be as competent as might be desired.

Marine and Interstate locomotive inspectors work directly under the U. S. Government as Civil Service appointees they must have certain experience to be able to qualify and pass a stiff examination. They hold their jobs for life and are retired on a pension if not removed for cause. This seldom happens.

A marine inspector must have had experience as an operating marine engineer and be under 45 yr. of age to first qualify. An interstate commerce inspector must have had certain experience operating locomotives or shop experience building them, preferably both. All these inspectors are supposed to have sufficient education to handle the formulas necessary in designing boilers and figuring safe working conditions. This generally implies at least a high school education in mathematics.

SCHOOLS DO NOT MAKE BOILER INSPECTORS

There are no schools for turning out boiler inspectors. Some of the larger insurance companies have facilities for apprenticing men and training them in their duties but they generally insist that the men taken on have certain prerequisites as to education and experience with machinery, especially in the operation of boilers. Experience in the fabrication of boilers is desirable to a certain extent but many a man who can do a workmanlike job driving a rivet or caulking a joint could not qualify as an inspector without further instruction and operating experience.

Most of all, the applicant should have had experience in the safe operation of boilers. They must have a wide knowledge of all the safety appliances that go on a boiler. They must have a minute knowledge of the A. S. M. E. Boiler Code and State laws which govern in the territory in which he operates. After the candidate is able to pass the examination and get a license, the insurance company will probably let him operate on more simple installations, as low pressure heating outfits, until he gets the experience necessary to be trustworthy on the high pressure boilers.

SPECIALISTS DEVELOPED BY EXPERIENCE

As the years pass by he becomes more and more competent as a specialist in his line. From looking into many thousand boilers and noticing signs of age and distress and poor management, and overheating on account of scale, he is able to locate the weak points of all makes of boilers, and to make sensible recommendations for their proper repair, and proper equipment and operation.

His recommendations must, however, first pass through the home office of the casualty company where his recommendations are reviewed by a thoroughly competent supervising engineer before they are passed on to the customer. The supervising engineer is generally a man who has passed many years himself as a boiler inspector.

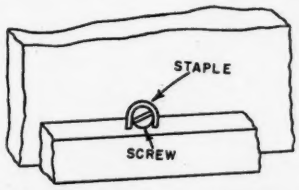
The real skill of a boiler inspector is the fact that he is alert to detect defects that would be overlooked by ordinary operators and mechanics. It is, however, necessary for the boiler inspector to constantly study and keep abreast of standard practice so as to properly advise his clientele. On the whole it is a good job and few who get started in it forsake the calling.

PRACTICAL HINTS AND KINKS

Screw-Staple Fastening Kink

By N. G. Near

SOMETIMES YOU want to fasten two overlapping strips of wood together. You don't want to nail them together, or cannot, and there isn't enough overlap to screw through either piece of wood without cracking or weakening the pieces.



This sketch shows a convenient and useful kink which has served the purpose very well in many instances. Simply drive a staple into one of the strips as indicated, leaving an opening just large enough for the screw to pass through. Then drive the screw, turning it until the two pieces are drawn together firmly. Use as many staples and screws along the strip, in this way, as may be necessary to hold the two pieces together securely.

* * *

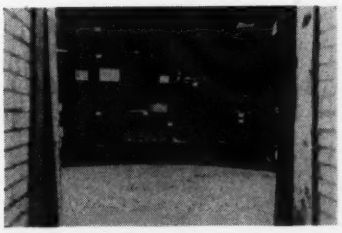
Valves and valve seats which have been hard faced must be brought down to finish size by grinding. A medium soft wheel between 46 and 60 is best at a surface speed of from 3000 to 4500 ft. per min. A hard wheel on higher speeds is apt to cause surface cracks from overheating.

* * *

As the backing tile and in much of the inside partitioning in a new building the Detroit Edison Co. used a block made from the ash collected from pulverized coal fired boilers. The ash combined with lime and a little rosin makes a serviceable, well finished block resembling concrete.

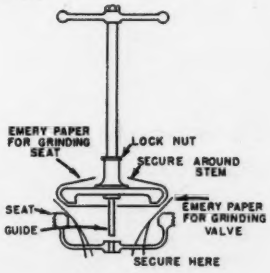
Store Room

AS PART of the modernization program for Austin, Minn., (described in a series of three articles by Carroll L. Elliott, and Joseph E. Edeskuty in the August, September and November, 1938, issues of POWER PLANT ENGINEERING) was a reinforced concrete stack with



Store room installed in the base of a circular stack at the Austin, Minn., municipal plant

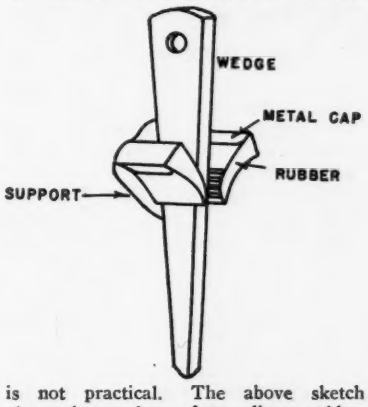
a diameter of somewhat over 26 ft. at the base. The breeching opening was 35 ft. above the floor and a sloping bottom with the lowest elevation 12 ft. above the boiler room floor was installed as a soot chamber. Below this, at the boiler room level the floor was fixed with a 6 in. reinforced concrete slab. The base of the stack, equipped with a steel door thus forms a convenient storage room used for pipe fittings, and miscellaneous materials for line construction.



Handy Clip

By Frank Bentley

FLAT tapered drifts used to knock apart drill sleeves and other tapered devices are often hung up and kept in unhandy places. If hung on some flat surface, it is hard for the fingers to grip and lift them off the usual hook or nail. On many metal surfaces where the drift would be handy a nail or hook



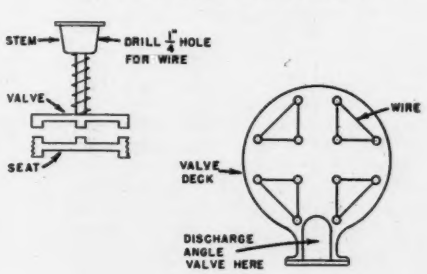
is not practical. The above sketch shows the novel use of an ordinary rubber wedge type household broom holder. Easy to push the tapered drift down into and between the stiff rubber wedge points. The drift always sets so the fingers can easily grip and pull it out for use. Two small wood screws attach it firmly to any wooden surface. Use two small stove bolts to attach to a sheet metal surface and two small tap screws will attach it to any solid metal part of a machine where it is handily reached and replaced. No amount of vibration will shake even a fairly heavy drift out of the rubber points. The broom holders are an inexpensive gadget on any household novelty counter, and are very handy for this purpose to keep these drifts handily "parked" for use and from becoming continually lost or misplaced about the plant.

Grinding Valves

By William T. Conley

RECENTLY I had to grind in two 7 in. valves and, lacking cutters, rigged up a piece of emery paper as drawn. It cuts reasonably fast and instead of an expected 8 hr. of grinding, I cut them down with the emery paper and ground them all in 2 hr.

On this same job a valve stem came out and cut the valve seat badly so I drilled holes in the stems for the nuts as they are made and by wiring them in sets I can easily overhaul them and they cannot come out as before.

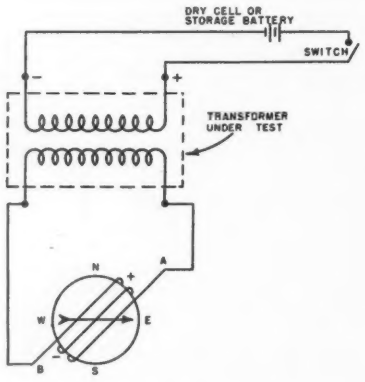


FOR THE PLANT ELECTRICIAN

Checking the Polarity of Transformers

RELATIVE POLARITY of an old transformer about to be connected to a circuit for parallel operation is often unknown and must be determined. A number of methods for ascertaining whether a transformer is of additive or subtractive polarity are available when power from a live line is available and when measuring instruments are at hand. When connecting a transformer to a dead line, however, such convenient facilities are often lacking.

A simple means of testing transformers for polarity under such conditions is shown in the accompanying diagram. It is a scheme presented some years ago in the Electric Journal and makes use of nothing more complicated than an ordinary compass made into a galvanometer by winding a few turns of lamp cord around it. When connections are made to a dry cell or automobile storage battery, the compass needle will be deflected in a clockwise direction when the battery circuit is suddenly opened and the



polarity of the transformer is additive. Should the polarity be subtractive, the deflection will, of course, be opposite or counter clockwise.

Where even a compass is not available an improvised galvanometer can be made from a hack saw blade. The blade is first magnetized by winding a few turns of lamp cord around it and energizing the coil thus made by connecting the ends to the battery terminals. It is then suspended on a thread in a manner permitting it to swing freely on its axis and thus function as a compass. To gain sufficient sensitivity the moving element should be as light as possible, especially if a single dry cell is used instead of a storage battery.

The duration of the deflecting current is instantaneous and may fail to produce a sufficiently noticeable effect if the moving element is weighty and presents too much inertia. When using a single dry cell, however, an ordinary hack saw blade will usually do.

The polarity of practically all distribution transformers is the same so there should not be much question in the field regarding particular transformers. Of course, all new transformers must be checked. This is ordinarily done by exciting one winding at a relatively low voltage and then measuring the voltage of the two windings connected in series. Whether this is greater or less than the applied voltage indicates the polarity.

Induction-Motor Insulation Test

WHEN INDUCTION MOTORS out of use for some time are being restored to service and when a regular overvoltage test is not feasible, another test with a direct-current supply source and a direct-current voltmeter is sometimes used. A 600 v. d.c. circuit, for example, might be available. A standard 750 v. d.c. voltmeter with known internal resistance is put in series with the trolley circuit and at the same time in series with the insulation to be tested. If there is a ground or other fault on the insulation, the voltmeter will read 600. If the insulation is in reasonably good condition the meter might read, say, 5 v. In such a case, if the applied voltage was 600 and the internal resistance of the voltmeter 60,000 ohms, the value of the insulation resistance would be

$$\frac{(600-5)\,60{,}000}{5} = \frac{595 \times 60{,}000}{5} =$$

7,140,000 ohms, that is, about seven megohms. This test will vary widely with humidity, temperature, and cleanliness; but, in general motors, for circuits up to 1000 v. ought to show somewhere near one megohm as a minimum before going into service.

The formula above can be expressed as follows:

$$R = \frac{r\,(E-e)}{e}$$

Where

R = insulation resistance of the winding under test.
r = internal voltmeter resistance.
E = direct-current testing voltage.
e = voltmeter reading.

This test is not to be taken as a substitute for the standard tests for such insulation. The recognized test is to place a higher voltage than normal on the insulation for a definite time interval. This voltage strain will seek out any weak spots and break them down, indicating the motor needs further attention. The A.I.E.E. establishes this voltage as twice normal plus 1000 v.

Commutator Maintenance on Large Machines

IN THE OPERATION of large electric generating and motor equipment two fundamental points should be kept in mind about the current collecting parts: First, some wear is to be expected and second, contrary to general experience with other types of machinery, wear and maintenance will be greater during the first few months of operation than thereafter. To provide for this wear the thickness of commutators and collectors is made greater than necessary for structural or electrical reasons and brushes are made easily replaceable.

Brushes used on commutators are either natural graphite or electrolytic carbon depending upon the electrical characteristics of the machine on which they are used. For the lower-speed machines and for small-capacity units, the electrical characteristics frequently permit the use of electro-graphitic carbon brushes. The characteristics of this brush material are such that a minimum amount of commutator wear is usually experienced, that is, the tendency toward grooving of the commutator is a minimum. Any scratches or scores on the commutator surface with this material seldom extends to great depth in the copper and is largely a surface condition. The electrographitic brush seldom gives a commutator the familiar chocolate coloring or polish, but tends to darken the commutator surface in an irregular, and, frequently, spotted manner. Such discoloration is not an indication of bad brush or commutator performance, but characteristics of the brush material, and is to be expected.

With those machines requiring natural graphite brushes for satisfactory operation, there is invariably a certain degree of grooving of the commutator copper. The positive brushes actually burn off a small amount of copper on the commutator, forming grooves between brush positions. This behavior has been observed ever since this type of brush has been used on high-speed commutators, and there is no present indication that conditions are likely to be changed. The natural graphite brush gives the commutator a high polish and tends to keep it clean, at the expense of copper wear.

The degree of grooving depends largely upon the amount of maintenance given commutators. If they are allowed to get in bad condition mechanically, grooving is always greatly increased. On new commutators pure

graphite brushes will cause grooving, but if the commutator surface is smoothed with a stone after a few weeks of operation, this grooving will not progress beyond a certain initial amount. The bright color of the copper obtained with these brushes tends to reflect light from the grooved surfaces and gives the impression of a much deeper groove than actually exists. It is never safe to judge the extent of the grooving merely by looking at it, and judgment on this feature should never be passed until the machine has been shut down and carefully inspected with straight edge and gage.

It is the expectation of the manufacturer that some commutator wear, scoring, scratching, or grooving will be encountered on all commutators, the exact nature of this wear depending upon brush material. Commutators have a very liberal wearing depth and their life varies from ten years on high-speed apparatus to twenty years, or more, on lower-speed machines, depending on the size and speed. There are certain severe applications sometimes met in electrolytic work in which the life may be less than ten years.

SYNCHRONOUS CONVERTER COLLECTORS

On collector rings, the same situation exists in connection with ring wear as mentioned in connection with the commutator wear. When a new machine is started, the collector-ring brushes are not perfectly fitted on the collector rings, and for the first few starts there is an abnormal concentration of current density on certain parts of the brush face, resulting in roughening of the ring and burning of the brushes. As the brushes wear in, the current density is reduced and this action no longer takes place to the same extent. The relatively high coefficient of friction existing between a metal alternating-current brush and the copper collector ring causes a certain amount of wear of both elements, and the grinding action of the two metallic surfaces leaves each in a semi-raw state. In recognition of this action collector rings have a very liberal wearing depth —one and one-eighth inch on a side for spider-type collectors. This standard of wearing depth was adopted about seven years ago, and there is no record of a single collector of this design having been worn out in this time.

Problem No. 5 Reappears

By Albert M. Ogent
Champaign, Ill.

EDITOR'S NOTE:—*Problem No. 5, published on p. 733 of the November issue, dealt with the detection of sudden load changes in a 500 v., d. c. system which changed gradually over a range of from 100 to 800 amp. The contest prize awards were published on p. 800 of the December issue. The following solution of the problem came in much too late to be considered in the prize awards, but the two schemes are unique, and are published here for that reason. The author expresses an interest in "remarks on the feasibility of the design", for as he says, "I do not possess the necessary equipment to run a test of my own and bear out my idea as incorporated in the two designs."*

SUDDEN VARIATION of current, being in the neighborhood of 50 amp., is sufficient to cause a partial collapse of the magnetic field set-up by the former constant current. This sudden drop of field strength will loose the field's hold on the steel plunger (lefthand sketch) so it will arc somewhat out of the solenoid. According to arrangement the plumb will drop so that its guided stem will dip into the mercury column, contact being thus established and the cell circuit completed.

The stem of the plumb consisting of two segments separated by a non-conductor or rather are glued together with a strip of paper interposed. The cell circuit so-closed, causes the electromagnet to work the lever, which in turn trips the camera shutters; a snapshot of the watch dial with its second arm being taken. Thus the time of current change is established. In the mean time the electric bell is set to ringing and rings until shut off by the notified party.

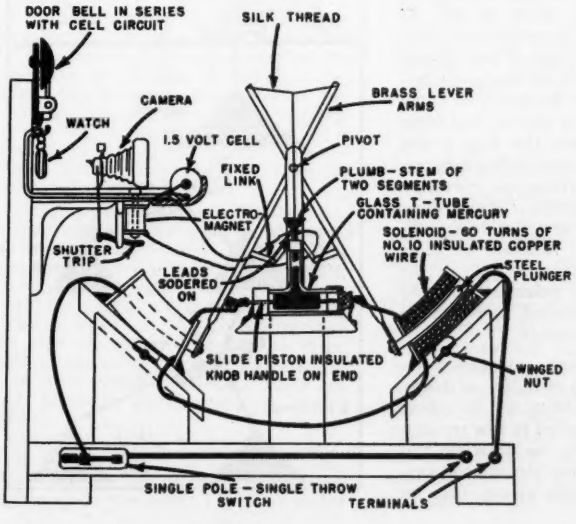
That the plumb stem may at all times be in neigh contact with the mercury column; in as much as the strength of the solenoid field varies with the gradual change of current, the column rises and falls with increase and drop of current respectively.

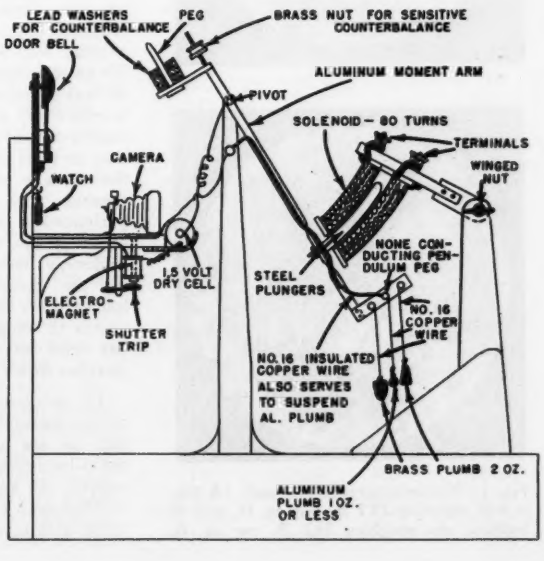
Relative motion of the two may be made fairly constant by setting the slide pistons to obtain a mercury gap offering the desired current resistance to obtain the desired heating effect to cause the desired relative rise and fall of the mercury column. Finer gap adjustments may be obtained with the bakelite nut, current being tapped from the solenoids as shown by the lefthand sketch.

Apparatus set-up on the right side is adaptable for use in series with the generator-electrolytic cell circuit where abrupt fluctuations of current are to be brought to the notification of the investigating party. As shown, provision is made for addition of counterweights to obtain a sensitive reaction of the moment arm to sudden rise or fall of current.

Cell circuit is completed when two of the suspended plumbs contact upon being disturbed by the sudden reaction of the moment arm to the change of field intensity of the solenoid due to the abrupt current change in power line. The two outer pendulums are not disturbed as much as the lighter aluminum plumb made-up pendulum, thus the latter is more free to move relative to the two heavier plumbed pendulums in as much as it has the lesser inertia to overcome.

Plumbs are suspended close enough to each other to permit a slight sudden disturbance or field impulse to excite the lighter pendulum and cause the latter to rebound against the two outer pendulums, establishing contact, and completing the cell circuit. Once the cell circuit is closed, the electromagnet actuates the shutter trip lever and a snapshot of the watch dial is taken. In the mean time the door bell is set to ringing, thus notifying the attendant, who sets film in the kodak for the next take.





Coal and Ash

Flyash

CHEMICAL ANALYSES of flyash vary widely for it may be analyzed in various ways. Typical results reported by J. F. Barkley of the Bureau of Mines for the two samples shown by Fig. 1 are given in Table I.

Table I. Analysis of the two flyash samples shown by Fig. 1

	Figure 1A Lighter Ash	Figure 1B Heavier Ash
Bulk Specific Gravity ..	0.38	0.58 (Dry Basis)
	Percent	
Combustible	20.3	28.8
Ash	79.7	71.2
Proximate Analysis:		
Volatile Matter	8.6	3.3
Fixed carbon	11.7	25.5
Ash	79.7	71.2
Ultimate Analysis:		
Carbon	13.4	26.5
Hydrogen	0.2	0.2
Oxygen	4.3	1.1
Nitrogen	0.1	0.1
Sulphur	2.3	0.9
Ash	79.7	71.2
Complete Analysis:		
Carbon, C	13.4	26.5
Hydrogen, H	0.2	0.2
Nitrogen, N	0.1	0.2
Silica, SiO_2	42.4	36.1
Aluminum Oxide, Al_2O_3	20.8	20.6
Ferric Oxide, Fe_2O_3	8.3	9.0
Calcium Oxide, CaO	1.7	1.5
Magnesium Oxide, MgO	0.4	0.6
Sodium Oxide, Na_2O	0.9	0.6
Potassium Oxide, K_2O	4.0	1.9
Sulphur trioxide, SO_3	6.2	1.8
Sulphide Sulphur	0.0	0.0
Free Sulphur	0.0	0.2[a]
Carbon Dioxide, CO_2	Trace	Trace
Chlorine, Cl	Trace	Trace

[a]Doubtful.

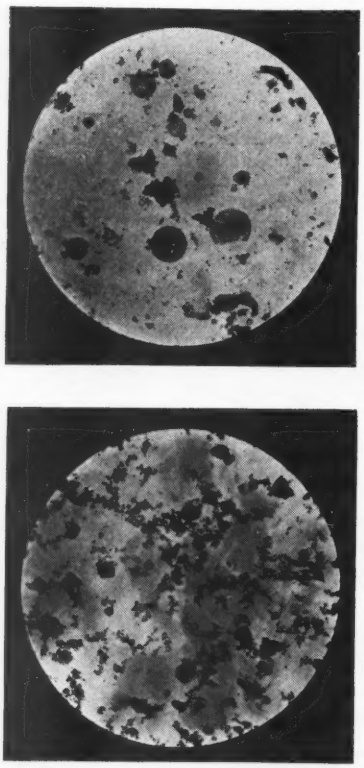


Fig. 1. Photomicrographs of flyash, 1A top, a dust weighing 23.7 lb. per cu. ft. and 1B bottom, one weighing 36.2 lb. per cu. ft.

Sieve analyses of flyash also vary widely and are further influenced by the fact that the heavier particles tend to drop out of the gases on the way to the top of the stack. The screen or sieve analysis of the flyash shown in Fig. 1A and 1B was as follows:

	Figure 1A Lighter Ash	Figure 1B Heavier Ash
Through 20 mesh	99.9	99.9
Through 48 mesh	97.7	97.8
Through 100 mesh	90.9	89.7
Through 200 mesh	75.5	64.4
On 200 mesh	24.5	35.6

A smaller percentage of the particles of the heavier ash passed through the 200 mesh screen. The tendency at present is to designate fine particle size such as is found in flyash by microns instead of sieve number. A micron is one-thousandth of a millimeter. Since a millimeter is about four hundredths of an inch, a particle diameter of about 1/100th of an inch would be 250 microns.

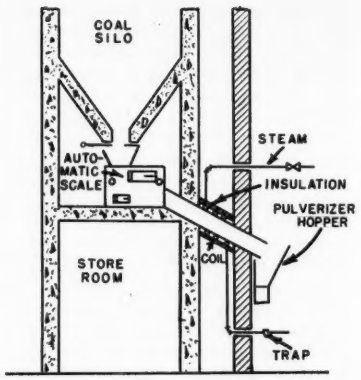
The smallest standardized sieve designation is 37 microns. For a study of smaller particles, special laboratory schemes are used such as an "air elutriator." In this apparatus the particles are separated by different velocities of upward moving air in a tube. Particle size is an important factor in the horizontal distance from the stack it will travel before reaching the ground.

Heating Coil Prevents Coal Chute from Freezing

By S. H. Coleman

FOR A NUMBER OF YEARS coal freezing in the exposed sections of the chutes feeding our pulverizers seriously affected the availability of these units. This trouble was especially bothersome when a pulverizer was held in standby service with its chute full of a fuel containing appreciable quantities of surface moisture. For a time, emptying the chutes whenever units were removed from active duty was given a trial, but without much success so far as readiness for instantaneous service was concerned. Failure of this scheme to effectively solve the problem was primarily caused by the tendency of damp coal to arch over and fail to feed from the storage silos into the coal scales together with occasional difficulties experienced in the starting and operation of the scales themselves. While these difficulties were not new, before emptying the chutes was resorted to there had always been enough fuel in the chutes to supply the pulverizers during the time interval needed to restore a positive flow from storage.

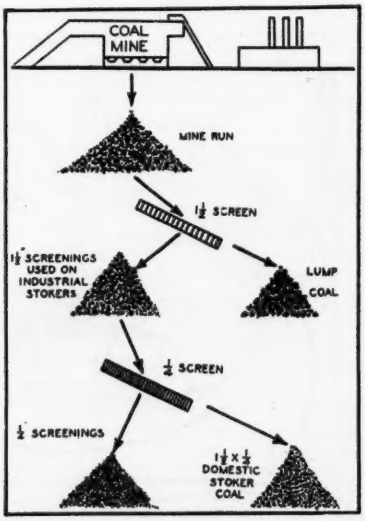
To safeguard these emergency reserves against the possibility of freezing, we are now heating all the chute areas formerly subjected to low temperatures. As shown in the drawing, this is done with encircling steam coils supplied with low pressure steam from the



plant heating system. An insulated housing around each chute and its heating coil is also provided to minimize loss of heat to the outside air. Since installing this heating arrangement, no loss of pulverizer availability resulting from coal freezing in the chutes has been experienced.

Coal Preparation

USERS OF DOMESTIC STOKERS are to an increasing extent demanding a prepared coal, a recent issue of the Fyr-Feeder News points out. Preparation of this fuel leaves as a by-product the fine sizes which screen out and which makes an ideal economical fuel for use with stokers which burn part of the coal in suspension and part on the grates. The various sizes are prepared at the mine by running the mine run over properly sized screens. The oversize is removed and the undersize rescreened until only the very small sizes and dust remain as the undersized from the last screen. The diagrammatic arrangement of screening process at a coal mine shown by the attached drawing illustrates how the fine screenings so well adapted to the spreader type stoker result from the increasing demand for sized coal.



Questions And Answers

Superheated Steam In Ironers

ON PAGE 806 of the December issue, P. H. C. asks about using superheated steam in his ironer. I would like to say I cannot see where he would be any better off with the superheat. He says the temperature now of the steam is 336 deg. F., which is about 97 lb. ga. pressure, or 112 lb. abs.

From his letter, I gather, he has a trap just beyond the ironer. This trap acts as a valve and lets only condensate pass. If he retains the same pressure with the superheat, the steam will not condense until it has cooled down to the temperature corresponding to that pressure, which is what he has now. The only ways he can increase the temperature is: to raise the pressure; or, superheat the steam and then blow it through with no trap. This would be very uneconomical. If he keeps the same pressure of steam he has now, and a trap in the line, he can superheat the steam to any temperature he wishes and he will have just what he has now, that is, 336 deg. F.

Everett H. Austin.

Springvale, Me.

* * *

SUPERHEATED steam can be used in this case, but will not give the results P. H. C. is after. The ironer may perform a little better all around, because of the better quality of the steam. The higher working temperature of the ironer, however, cannot be obtained, without raising the pressure of the supply steam, regardless of the amount of superheat. The superheated steam entering the ironer cannot condense, without cooling down first to the saturated steam temperature corresponding to the pressure in the ironer. At the present the temperature of the condensate is 336 deg. F., which corresponds to a pressure of about 98 lbs. per sq. in. ga. In order to raise the temperature of the condensate to 450 deg. F. a pressure of around 430 lb. would be required, which is most likely too high for the ironer.

Several years ago the writer was confronted with a similar problem. The temperature of a drum had to be raised. The construction of this drum did not allow for a high enough pressure. Glycerin was then heated by means of a high pressure steam coil in a separate tank and then circulated through the drum with a pump. In place of the glycerin some other organic compound, which are made especially for this purpose, can be used.

In the foregoing problem, however, P. H. C. may do well to check the steam supply line as well as the trap for size. Both may be too small. The more steam that can be supplied to the ironer and the more condensate that can be removed, the better will the ironer keep up the temperature. F. C. R.

Fair Lawn, N. J.

* * *

THE INQUIRY relating to the operation of a laundry ironer is particularly interesting, because it is one of those which are comparatively simple in theory, but when we try to work out a practical answer, the results are likely to be somewhat staggering.

As the temperature of the steam between the ironer and the trap is 336 deg. F., we may assume that the pressure is about 100 lbs. ga., and as the 12 b.hp. referred to is presumably the present steam demand, we may assume that it amounts to around 400 lb. an hr. Under these conditions, the steam would have about 880 B.t.u. per pound, available as latent heat, so by condensing it we should have a total of approximately 350,000 B.t.u. for heating, or replacing the heat, dissipated by the iron.

If we superheat a pound of the steam, say, 120 deg., we only put into it about half 120, or roughly 60 B.t.u. of additional heat, and that is all we could take out of it, before the temperature dropped to our original 336 or 340 deg. F., but presumably we cannot do this. If we needed a minimum temperature of about 440 deg. at the iron, we could only take out 10 B.t.u. per lb., so we should require 35,000 lb. of steam per hr. to equal our original 400 lb.

Of course, if we could afford to allow a 40 deg. temperature drop, we could do with 17,500 lb. of steam, but even that represents over 500 b.hp., so obviously the thing is getting quite out of bounds, as far as practical limits are concerned, and it is not worth while to go any further. JAMES O. G. GIBBONS.

Bloomfield, N. J.

Coal Formulas

ON PAGE 738 of the November issue, Richard E. Murphy, Mansfield, O., requested formulas for calculating the heating value of coal from the proximate analysis. The large number of replies received made it impossible to use them all in a single issue. Four were printed on page 804 of the December issue and some others follow. A large number make use of Dulong's well known formula discussed by H. G. Sheer in the December issue. Leo S. Swarts, Newark, N. Y., draws attention to the fact that "this 62,000 (a constant in the second part of the formula) is the heating value of 1 lb. of hydrogen in B.t.u." It is well to point out that the various constants used in this formula by different authorities do not always agree.

This formula requires an ultimate analysis, which may be calculated from the proximate analysis by formula. These methods are discussed in considerable detail by Robert P. Vail, Texas Technological College, Lubbock, Tex.; B. Caveman, Municipal Asphalt Plant, Cincinnati, O.; and J. R. Darnell, Chicago, Ill. The latter, who by the way was for many years an associate editor of Power Plant Engineering but eventually went back to his first love, the petroleum industry, goes into the application of these formulas to different coals in considerable detail and his reply will be published later.

Both C. C. Tinker, Detroit Edison Co., Lapeer, Mich., and Chester V. Chapman, Celina Municipal Utilities, Celina, O., have found the Lucke formula satisfactory. This was discussed by James O. G. Gibbons in the December issue and need not be repeated.

H. G. Mettlach, fuel engineer of the Pennsylvania Coal & Coke Corp., New York City, sent in a formula which he says "is used widely in the coal trade, and I think was originally offered by Dr. Parr of the Bureau of Mines" (later of the University of Illinois and an outstanding authority on fuels and calorimetry). This rule or formula, said to be accurate within 100 B.t.u., follows:

1. Deduct sum of Moisture and Ash from 100.
2. Divide result into percentage of fixed carbon.
3. Multiply this result by 100.
4. Consult table below to find B.t.u. opposite this number.
5. Multiply this B.t.u. figure by figure found by Rule 1.
6. Point off two decimal places. The resulting whole number is B.t.u.

Per ct.	B.T.U.	Per ct.	B.T.U.
50	12240	75	15750
51	12600	76	15780
52	12840	77	15800
53	13100	78	15820
54	13320	79	15830
55	13560	80	15840
56	13800	81	15840
57	14040	82	15830
58	14220	83	15810
59	14400	84	15780
60	14580	85	15750
61	14760	86	15710
62	14760	87	15660
63	15120	88	15600
64	15210	89	15540
65	15290	90	15480
66	15360	91	15390
67	15420	92	15300
68	15480	93	15210
69	15540	94	15120
70	15590	95	15000
71	15630	96	14880
72	15660	97	14760
73	15690	98	14670
74	15720	99	14580

As an example—suppose a coal to contain 1.00 per cent moisture, 21.50 per cent volatile combustile matter, 68.60 per cent fixed carbon and 8.90 per cent ash.

1. 100—(1.00+8.90)=90.10.
2. 68.60÷90.10=0.7605.
3. 0.7605×100=76.05.
4. By table 76 corresponds to 15,780 B.T.U.
5. 15,780×90.10=1,421,778
6. Point off two decimal places= 14,217.78. The answer is 14,218 B.T.U. in the coal.

U. J. Grant, Rittman, O., makes use of known heating values for different districts and corrects this to the "as fired basis." Only the ash and moisture values are used and he reports calculated values to be checked within 100 B.t.u. by reputable laboratories. A portion of his letter follows:

"It is especially interesting to the engineer of the smal plant who is never satisfied that he has a true heating value of the coal being fired and frequent outside laboratory determination are not warranted. Over the past 8 or 10 yr. the following proceedure has proven very satisfactory when the moisture and ash can be determined and when the district and seam where the coal is mined is known. The customer should always know where his coal comes from.

"Using the heating value of the coal on a moisture and ash free basis (which value is available for each coal in every district) the total of the moisture and ash percentages from your proximate analysis is subtracted from 100 per cent. The result times your heating value on a moisture and ash free basis will be your heating value as fired.

"As an example—say the coal in question is from an Ohio No. 8 seam which say has a heating value of 14,800 B.t.u. on a moisture and ash free basis. Now if an analysis of this coal shows 10.5 per cent ash and 4.5 per cent moisture, the total of the moisture and ash would be 15.0 per cent. Using the formula above we would have 100—15 =85 per cent which multiplied by 14,800 would be 12,580 B.t.u. heating value as fired."

Tracy Nesbitt, Vienna, Md., has some practical suggestions about approximate moisture and ash determinations where a laboratory test is not available because of time or expense. He says:

"True moisture content is a tedious analysis to be made only by a laboratory. However, for practical purposes, weigh out a small amount of the sample, put it in a container, cover it with a cloth, and set it on top of the boiler for several hours. After exposure to the heat, weigh again. Divide the difference in weight by the original weight, and the result is approximately the percentage of moisture in the coal. Don't get it too hot, or volatile will be driven off.

"Weigh another small sample, and burn it completely. Weigh the ash. The difference in weight divided by the original weight is the percentage of ash.

"The B.t.u. value of the coal can now be determined quite accurately, provided the location of the mine is known. The first step is to convert the percentage of volatile matter "as received" to the combustible basis, that is, ash-and-moisture-free coal."

From here on Mr. Nesbitt prefers the Evans Equations, which, judging from the replies received, is the most popular among engineers. W. F. Cantieri, Dresden, N. Y., says: "The Evans equations, I have found, give values somewhat higher than calorimeter determinations on many fuels. I would suggest that Mr. Murphy pick the one most suited to his coal as shown by the location of the mine and the volatile content and modify the constant for V to suit his own conditions more closely."

Mr. Cantieri summarizes the necessary data and formulas as follows:

Location of Mine	Range of Volatile	Equation and Constants
A	0—16%	H=14,550+7810V
	16—36%	=16,160—2250V
	36% up	=18,750—9440V
B	all values	=16,062—3830V

Group A includes coals from Pa., Ohio, W. Va., Md., Va., Ky., Ga., Tenn., Ala., Ind., Iowa., Neb., Kan., Mo., Okla., Ark. and Texas. Group B includes coals from Ill. and Mich.

George V. Parmelee, Department of Mechanical Engineering, Fenn College, Cleveland, O., favors these same formulas and adds:

"In each equation H. is the higher heating value of the combustible in B.t.u. per pound, and V is the fraction of volatile matter in the combustible. To convert to an "as fired" basis, the above values must be multiplied by the fraction of combustible (coal—ash —moisture) per pound of coal.

"These equations are from Bulletin No. 3 of the Cornell Engineering Experiment Station by F. C. Evans (also in Sebley Journal of Engineering, Oct., 1924).

"It may be of value to know that the same bulletin includes formulae for the empirical determination of both total carbon and total hydrogen in the combustible. In the absence of an ultimate analysis of the coal, these may be useful in working out the heat balance of the steam generator."

John A. McNary, Tucson, Ariz., says: "These formulas do not apply to cannel coal and lignite from many states" which might be amplified to exclude Rocky Mountain and Pacific Coast fields except in the case of the Las Animas (Colo.), field which follows the Appalachian field formulas.

Oil Difficulties in a Refrigeration Plant

DOWN IN OHIO G. R. W. has a problem on his hands and asks for help. One of his refrigerating compressors is pumping oil. He wants to know how to rid the system of the oil that is already there, how to prevent oil from reaching the heat transfer surfaces in the future and, if possible, how to stop oil pumping by the compressor?

The Idler Pulley Again

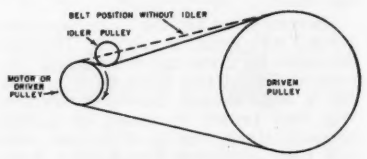
I WAS startled when I read, in the January issue on page 95 under the heading Where the Idler Pulley Should Be Located, that Robert Kemp accuses me of advising C. L. W. to place a wrapper pulley on the tight side of a belt drive. Having been connected with power transmission for more than 30 yr. and having never advised the use of a wrapper pulley on the tight side of a drive, I naturally looked back at my article as published in the November issue and I find that I didn't mention either the slack or the tight side. I took it for granted that C. L. W. would know that wrapper pulleys are always placed on the slack side.

On the other hand, it is obvious that Mr. Kemp's drawings are incorrect because C. L. W. clearly states that the slack side is "on top". Mr. Kemp shows the slack side on the bottom. It is not all wrong to place a wrapper pulley in the center of a drive as sketched by Mr. Kemp and labeled "wrong". But of course the wrapper pulley must be on the slack side and not on the tight side of the drive. Mr. Kemp obviously understands belts and belt drives, but it is clear that he misinterpreted C. L. W.'s original problem, and he apparently *thought* I advised the use of a wrapper pulley on the tight side.

Newark, N. J. W. F. SCHAPHORST

* * *

REFERRING to the January issue, page 95, Mr. Kemp says "No matter what the size of the drive . . . the idler pulley should always be placed . . . 1 or 1½" from the . . . driven pulley." While I can't agree with Mr. Schaphorst's solution of the original problem, (page 738, November, answering the original inquery on page 676, October) neither can I agree unqualifiedly with Mr. Kemp. Rather, in most instances of belt drive, in which the driver is smaller than the driven pulley, I disagree.



In the instance covered by the enclosed sketch, without an idler we have a belt contact of 225 deg. on the driven pulley and only 135 on the driver. By placing the idler as shown, close to the driver, it is possible to increase its arc of contact 33 1/3 per cent, with only

High Water Alarm Circuits

CAN SOMEONE supply a sketch or diagram of the electrical circuit required for a high water alarm. This should ring a 110v. a.c. bell and light a 110v. a.c. light, both located in the basement pump room, when the roof tank is in danger of overflowing. The light should not go off until the water level subsides but provision should be made to stop the bell by pushing a button. However, the bell should be automatically reincorporated in the alarm circuit when the water level subsides, so that the bell may ring again the next time high water occurs. The alarm circuit and relays may operate on either 6 volts a.c. or d.c.

Tried to construct a working diagram of this problem, but always hit a dead end somewhere. Maybe one of the numerous readers of PE&E will be able to help. **C. E.**

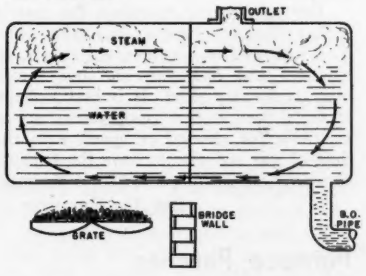
a slight addition over belt length with no idler, obviously greatly reducing the amount of slippage present.

Were this same idler placed near the large driven pulley, the arc of contact on this member, already adequate, would be slightly increased, but with practically no gain on the smaller driving pulley. Consequently, with the idler placed as shown, removing slack from any belt wear results in further tightening the grip on the driver and thus furthering the efficiency of the drive.

Longview, Tex. ELTON STERRETT

Circulation in H.r.t. Boilers

THE QUESTION asked in the November issue (p. 736) relative to circulation of water in a horizontal tubular boiler is timely and one which has been the subject of much controversy. Doubtless, many engineers have been shown glass models which illustrate how the water circulates, but these models do not show the real circulation, since the operator can control the flow or path of the water by diffusion of the heat according to his own inclinations. In many instances, the model is not operated for any length of time and, therefore, this will also mislead the observer.



The accompanying illustration shows how the water is intended to circulate in a horizontal tubular boiler, but it must be stated that there is generally no authentic or positive flow, since the restriction and spacing of the tubes is the dominant factor. In other words, many manufacturers will crowd as many tubes as possible into a boiler, thereby cutting down the space between the tubes and depending upon the center lane to carry the steam bubbles to the surface of the water at the front end. These constrictions may in many instances cause a reversal of the water, but broadly speaking, the plates over the fire are the ones receiving the most heat, and, therefore, as the steam bubbles are liberated, the cooler water at the rear of the boiler moves toward the front of the boiler.

The difference in the density of the water at the front and rear of the boiler does not cause the water to circulate, but the circulation begins when the boiler starts to steam and the faster the steam bubbles ascend the more rapid will be the circulation. As heretofore stated, the restrictions of the narrow paths in the tube lanes prevent this rapid ascension, and at times may cause reversal of the flow. H. B. S.

* * *

THE BULK of water circulation in an H.r.t. boiler forms a number 8, lying on its side. Upflow occurs mainly on both tubesheets, the downflow near the shell and middle of the boiler, with a number of eddy currents up between the tubes and down along the shell. This statement is the result of some research work, carried on by a prominent boiler maker, who used a homemade 1/10 hp. model boiler of metal except the shell, which he made of pyrex glass.

Being hard to convince, I repeated that test, using also a 1/10 hp. model with the addition of a surface condenser and a scale for weighing the condensate. Thus I found out on 3 lbs. working pressure, that the boiler maker's statement was correct only when the boiler was worked considerably under its rating.

At full rating, and when forced to 120-140 per cent of rated capacity, the flow or circulation was so turbulent, that there was absolute no definite path of the water, throughout the boiler. The tube arrangement was as usual, not staggered, but with space provided for a bottom manhole in the front tube sheet. As I am still very much interested in that question of Mr. Van Dyck, I had like to see more opinions printed about the subject, in this column.

On my own experiment as described above, I used iron tubesheets ¼ in. thick, with very thin ¼ in. steel tubes. The furnace and everything else was in proper proportion, resembling the conventional H.r.t. boiler with bridge wall, back connection and front uptake, to get as nearly as possible average conditions the same as in a full-sized boiler. For firing I used a homemade gas burner, which issued a number of small flames over, what was supposed to be a square grate surface.

Unfortunately I forgot and kept no record of all the dimensions of the various parts. The tubes were merely soldered into the sheets with 50/50 hard solder, and during the test no feedwater was fed. The test was repeated several times, each time for 15 min., after the water had reached the boiling point of 222 deg. F. For a pressure gage I used the glass fill pipe, exactly 7 ft. high above the water level in the boiler, and connected to the water space of the boiler.

Brooklyn, N. Y. H. ETTELT

How Can Cylinder Oils Be Tested?

REPLYING to Richard E. Murphy's question in the November issue, p. 737, the writer knows of no better or simpler way in which to analyze or test cylinder oils than the "Look and See Method," as follows:

After a given oil has been used for a while at a rate of feed that is supposed to be correct for that oil, remove the cylinder head and subject the interior to a careful examination. Take four pieces of white paper and mark them "Top", "Bottom", "Right Side" and "Left Side". Rub the "Top" piece of paper along the upper surface, the "Bottom" piece along the bottom, and so on. If there is no evidence of oil on any of the papers, if the top piece shows no oil while the bottom one does, etc., it is obvious that the lubrication can be improved. To be properly lubricated the entire cylinder surface must be oily.

By following this method consistently, keeping the test pieces in dated envelopes, and comparing them from time to time, you have a simple, practical, and excellent way in which to make tests and keep records that *mean* something.

Newark, N. J. W. F. SCHAPHORST

* * *

THERE ARE a number of simple oil tests which any ordinary engineer can make, without relying upon an expensive analysis by a reputable chemist. It is generally known that there are mixtures of different oils sometimes offered by manufacturers for cylinder lubrication; mineral oil as the main part is often mixed with sperm, whale or lard oil as a compromise between price, body, and fluidity. Such mixtures should not be used inside a cylinder; only the best mineral oil should be used for this purpose. But how can you tell, mechanically, whether an oil is adulterated or not?

THE PURITY TEST: This test is made by shaking a small quantity of the sample in a bottle, with a quick jerking motion, so as to produce air bubbles. If the oil be pure the bubbles will soon burst and disappear, but if mixed with other oils, they will rise to the surface and collect.

Certain grades of oil frequently show an acid reaction and are undesirable for lubricating purposes, especially for cylinders.

Who Knows About Condensate Pumps?

AT THE CREAMERY where I work, we have a problem regarding the proper type and size of condensate return pump to use and I would like to have the opinion of other engineers on the subject.

Our skim milk is condensed preparatory for drying by the roller process—in a Buffalovak condenser. We wish to save the condensate, about 1000 gal. per hr. at a temperature of about 190 deg. F., from the steam required to heat and evaporate the milk. There is little or no pressure on the suction line and about 150 ft. of 2 in. discharge pipe to a hot well. Traps won't work as there is not enough pressure to operate them. We have used a 4½ by 3 by 4 in., also a 5¼ by 3½ by 5 in. duplex reciprocating steam pump. Each pumps the condensate fairly well but each breaks the discharge valve stems regularly.

What make, size and style pump would you recommend?

W. P. C.

THE ACID TEST: This test is performed by mixing a small quantity of oil with warm water or alcohol, and testing with blue litmus paper, which will turn red if any free acid be present. (H_2SO_4 in the case of mineral oils)

As mentioned above, oftentimes mineral oils are adulterated and should the adulterant be any form of vegetable oil it is easily detected since vegetable oils are gradually decomposed by the oxidizing influence of the atmosphere giving off a sour, rancid smell.

THE RANCID TEST: A rancid oil is indicated by the smell when a few drops are rubbed briskly between the hands. Color for the different grades of oils varies from a light yellow to a dark brown, but regardless of color, it is of prime importance that the oil be clear.

TEST FOR CLEARNESS: The test is made by taking a sample from a barrel that has been well rolled and shaken. The testing glass or bottle should be transparent and the oil if very cold should be slightly warmed. The oil then, if of good quality, should be clear.

SUSPENDED MATTER is easily seen in the lighter oils, and in the case of the darker oils, the amount of suspended particles is determined by mixing and shaking with a relatively large quantity of gasoline.

Orlando, Fla. BERT W. HUMPHRIES

* * *

TESTS ON ENGINE oils and greases can be conducted with the following simple and inexpensive equipment: An iron or tin pan about 10 in. in diam. and 4 in. in height; a metal cup about the shape and size of a water glass; two thermometers, one of the ordinary type, the other of a high grade, graduated to at least 500 deg. F.; several clear ½ pint bottles; a glass test tube; a large sheet of plate glass; a small funnel; a small sauce pan; and red and blue litmus paper.

To test for acids and alkalies, place about a teaspoonful of the oil in 5 or 6 times that amount of water at the boiling point and dip into it a strip of the red litmus. If the paper turns blue quickly the oil is alkaline, if it remains red the oil is acid, if it slowly turns light blue the oil is neutral. Then check with the blue litmus. If it turns red rapidly the oil is acid, if it remains blue the oil is alkaline, if it slowly turns pink the oil is neutral.

As a comparative test of the viscosities of different oils place several drops of each on the sheet of glass while it is level, then raise one end about an inch and block it in place. The samples will flow down and the one reaching the bottom first will have the lowest viscosity.

To find the congealing point, place the test tube containing a sample of oil and a thermometer in the panful of cracked ice mixed with rock salt and sal soda. Cover the pan with a cloth until the oil is solidified. Remove the test tube and place in an inclined position. When the oil begins to flow the thermometer will indicate the congealing point.

To find the flash and fire points place the cup almost full of oil in the pan, surround it with clean white sand, and heat over a flame to 300 deg. F. Then pass a flame slowly over the oil, repeating this at each two or three degrees temperature rise. When the vapor flashes note the temperature as the flash point. Continue until the oil itself ignites and burns. The temperature at which this occurs is the fire point.

To detect sulphur in the oil heat a sample to 300 deg. as in the above test and maintain that temperature for 15 min. After cooling, if the oil is darker in color than the original sample, it contains sulphur and is unfit for lubrication in high temperatures.

To determine pressure of wax, gum, paraffin, etc., used to artificially increase viscosity, thoroughly mix 1 oz. of oil with 2 oz. of gasoline and allow to settle. The gums, waxes, etc., will settle and any considerable amount of sediment is cause to reject an oil.

To detect presence of animal or vegetable oils place about ½ pint of oil in the pan, add one or two ounces of caustic soda or concentrated lye, and boil for 30 min. After cooling, examine; soap on the surface indicates the presence of fatty oils.

Usually a straight mineral oil should be used for cylinder lubrication, although a properly compounded oil can be used to advantage with saturated steam at pressures below 130 lb. ga. as it forms an emulsion that adheres to the cylinder walls.

Fatty oils are likely to carbonize and decompose under high temperatures and form stearic, oleic and palmetic acids which readily attack metals.

The proper cylinder oil depends on many factors, such as: steam pressure, quality, and superheat, size, type, and speed of the piston. The flash point should never be below 400 deg. F.

The best thing to do is to call in a representative from one or several of the larger and reputable oil companies. Practically all the large companies maintain such a service and there is no cost or obligation. If the recommendations made by the representative are followed there will be no lubrication troubles and no necessity of conducting tests of your own. The high grade oils are cheapest in the long run.

Houston, Texas H. G. SCHEER

Dry Ice

PLANTS to produce dry ice and liquid CO_2 (see p. 677 October and p. 739 November) require more equipment than water ice plants, so the cost is higher by about $100,000 to $200,000 for a plant of your size, i. e., 7500 gal. of 100 per cent pure alcohol per day (24 hr.). With good operation and equipment such a system should give about 16 t. of gas (24 hr.) in an average day. The gas should have a steady flow for 24 hr. per day. Mash has its starting and ending points of about 40 min. and 40-60 min. respectively, which must be considered.

Needed equipment is as follows:

(1) Scrubber for alcohol, etc.

(2) Purification system. Two good types are made, one using coke (charcoal) and the other steam and water used only.

(3) The compression system. This may be used as: 1, non-regenerative cycle; 2, regenerative cycle; 3, complete re-expansion; 4, partly ammonia cooled; 5, York cycle.

Pressures used, automatic or hand operation, water source and temperature, cutting and packing of ice and the price received are all part of the economies of the problem.

For year round operation the cost is higher than for summer operation only. You will need two men on each shift, an engineer and operator, and one repair man on the day shift. It is best to have steam driven engine compressors so as to allow for change of speed with the flow of gas and also to have the exhaust available for heating at 10 to 15 lb. gage.

DRY ICE ENGINEER

Furnace Patches

THE BEST thing I ever used to repair cracks in a boiler setting was mineral wool mixed-up with a little fire clay to the thickness of heavy cream. Mix with the wool, take a putty knife and work it in cracks good. Wool will expand and contract with setting and fire clay will exclude the air. However, it will have to be looked after once in a while because the crack will gradually get wider. Anything that sets hard will make the crack open up that much quicker.

Redmond, Ore. C. C. COLLINS

Contest Problem VI, given on page 801 of the December issue, left our Hero puzzled over his fire protection system which is supplied from the public water supply at 75 lb. pressure. The pressure on the sprinklers however increases gradually to 120-130 lb. and this worried him. He wanted to know what causes the increase and how it can be corrected. His suggested solution of a simple relief valve did not seem to be entirely satisfactory.

How Would You Do It?

Problem VI. Pressure Rise In Sprinkler Systems

TAKING ADVANTAGE of experience gained over the past few months, the Board of Judges, securely buttoned their whiskers inside their respective vests before tackling Problem VI. This saved wear and tear on their hirsute adornment and cheated the barbers out of extra trims. This did not, however, ease the mental strain and after another session, some of them will undoubtedly be in the psychopathic ward watching purple insurance inspectors climbing up the walls swinging from sprinkler heads, playing hide and seek with animated check valves, expansion tanks and risers.

If misery loves company, our Hero should be happy for judging from the large number of answers, many based on personal experience, sprinkleritis is a common complaint with the same symptoms as the every day pain in the neck. Apparently the trouble is not of an engineering nature but grows out of the restrictions and regulations built up through the years by the insurance companies. This is very well stated by W. F. Schaphorst as: "The nigger in the woodpile surrounding our Hero's problem appears to be the insurance company . . . insurance companies, I have found, are an entirely unknown factor." The importance of the insurance company in the solution of the problem was recognized definitely by a few, vaguely by perhaps half, and entirely neglected by the balance.

A dozen or more, for instance, suggested removing the check valve, a very definite solution of the problem, yet hardly adequate in this case unless our Hero was willing to tell the insurance company to go wash an elephant, lose his water service and perhaps take on a fight with the local building inspector. Regulations covering Sprinkler Equipment, N.B.F.U. Pamphlet No. 13, says in paragraph 412: "Check valves shall be installed in all sources of supply . . ." in paragraph 721 "Where connections are made from public water works systems it is often desirable to have double check valves," and in paragraph B801, "A standard 4 in. Siamese Fire Department connection shall be provided wherever public water supply or pumpers are available."

All of these are surrounded, modified and circumvented by ands, ifs, buts and whereas, differences between standard and Class B systems, water works, pumps, gravity tank or pressure tank water supply, a distinction between the words shall, must, should and preferably, and the fact that in many cases approval of detail is left to the local inspector. Our Hero has, therefore, to be not only a Philadelphia lawyer but a good politician as well.

Nevertheless, the regulations are specific on many points and all engineers interested in sprinkler systems should have a copy of N.B.F.U. Pamphlet No. 13. This may be obtained free of charge from the National Board of Fire Underwriters, 85 John St., New York, N. Y. There are also other special pamphlets covering sprinkler systems for special products like plastics, film, paint spray booths, etc., as well as lists of equipment which has been tested and approved for use by the Underwriters' Laboratories. The regulations are aimed at the maximum protection of life and property and, in many cases, this involves protection of public water supplies against contamination.

Problem No. 8—Turbine Capacity and Arrangement

Bedeviled for months by pumps, refrigeration, electrical and sprinkler systems problems, our Hero was groggy before Problem 8 came up. He is now hanging on the ropes and may be knocked out unless he gets help quick. Among other things he has an old plant with three 350-hp. 150 lb. ga. stoker fired boilers and three 250 v. d.c. steam engine generator sets. One of these is a 175 kw., four valve engine unit; one a 100 kw., four valve engine unit, and the other a 75 kw. slide valve unit. The boilers are not in such good shape but the engine units are. The electrical load averages around 220 kw., with an occasional peak to about 275 kw. The steam load averages about 10,000 lb. of steam per hour most of which passes through the engine and is exhausted to a 5 lb. ga. process system. At present there is a fairly good balance between the steam and electric load. The management is considering expansion in the factory which will not change the steam load but will increase the average electric load to about 600 kw. and the peak to about 725 kw. The management would like to retain the present d.c. motors but use a.c. for the new equipment. The layout of the new power plant has been put up to our Hero, he is not quite sure of his ability to solve the problem correctly and is puzzled as to whether he should use new, low or high pressure boilers; condensing or non-condensing prime movers; or, perhaps a high pressure condensing-extraction turbine. Ample condensing water is available. (Entries must be in by February 25 and should not exceed 1000 words—for complete contest rules see page 461 of the July, 1939, issue.)

The most sensible advice, offered by a large number of those evidently familiar with sprinkler systems, is for our Hero to forget about the pressure rise. Paragraph 909 of the regulations says, "All systems should be tested at not less than 150 lb. pressure for 2 hr. or at 50 lb. in excess of the normal pressure when the normal pressure is in excess of 100 lb." The use of "should" instead of "shall" indicates only an advisory provision, so that our Hero's fears about the pressure being excessive for his particular job may be well founded.

Those answering the problem are quite definitely divided into two schools: those who blame the trouble on expansion due to temperature; and those who blame water hammer. Many consider the possibility of both being to blame and it is interesting to note that this group almost without exception dismisses thermal expansion with slight consideration and places the blame on water hammer. The thermal expansion advocates outnumber the water hammer advocates about three to one. Several mentioned the possibility of a hidden connection somewhere with another higher pressure system.

Both preventive and remedial means are suggested by the replies. In addition to the removal of the check valve, and forgetting about the pressure rise, both mentioned earlier, there are a number of other solutions—some practical, some impractical. Changing from a wet to a dry system was mentioned as a step permitted by the regulations. In some cases the remedies conflicted, for instance the suggestion that air be vented as completely as possible on one hand and that the system be drained and refilled to increase the air content on the other.

In the main, however, the suggested remedies fell into two classes: air chambers or some form of bypass around the check valve. Use of a relief valve, a very obvious remedy, is more or less ruled out by the wording of the problem itself. Those who considered water hammer responsible for the pressure rise, suggested the use of an air chamber ahead of the check valve as a preventive measure. Those who considered thermal expansion responsible suggested the use of an air chamber on the sprinkler side of the check as an expansion tank.

Suggestions for relieving the excessive pressure around or through the check valve fell into six groups: 1, filing a small nick in the check; 2, drilling a small hole in the check; 3, a small uncontrolled bypass around the check valve; 4, a manually operated valve in the bypass; 5, a spring loaded relief valve in the bypass; 6, a check valve in the bypass with the direction of flow reversed from that of the main check.

Letters show that most if not all of the suggested methods are now, or have been, in use, indicating that the problem is widespread and not as simple as might appear on the surface. Under the circumstances we pass the various suggestions on to our Hero with the tip that he fight out the details with the local insurance inspector.

Inasmuch as the engineering involved was secondary to other factors the first prize was awarded to Mr. Brown because he gave consideration to both factors that might be the cause of the trouble, indicated a familiarity with regulations covering sprinkler equipment installations by specific quotations and interpreted those recommendations into concrete recommendations for correcting the trouble. The prize winning letters follow, together with excerpts from many of the others. These last are not all complete for the majority offered more or less complete discussions of the problem with several solutions. Insofar as practical duplication has been eliminated and only the parts bringing out some point of interest have been included.

FIRST PRIZE AWARD

Problem VI

By Harold F. Brown

Chicago, Ill.

In Problem No. 6 our hero apparently has given us quite a puzzle but I believe he has either overlooked his source of trouble or has not thought it sufficiently important to be taken into consideration.

First, "How can this pressure rise be accounted for?" There are two possibilities.

First. Expansion of materials caused by a rise in temperature. If the sprinkler system were filled with cold water and air this might account for the first rise in pressure but after the water and air had reached room temperature the pressure would not rise again if enough water were let out to reduce the pressure to 75 lb. Therefore we can count that out as the cause of our trouble.

Second. Next we will consider water hammer caused by valves on the water main. Here we cannot find any reason why the trouble will not continue unless something is done to stop it.

We find the answer to the problem in the National Board of Fire Underwriter's Pamphlet No. 13, page 50, paragraph No. 910.

"Relief Valves or Air Chambers.—Where connections are made from public mains, subject to severe water hammer (especially where pressure is in excess of 100 lb.), it is advisable to provide a relief valve, properly connected to a drain; or an air chamber in the connection. If an air chamber is used, it should be located close to where the pipe comes through wall, and back of all other valves, and at right angle to other valves, so as to take the full force of water hammer.

"Air chambers shall have a capacity of not less than 4 cubic feet, shall be controlled by an O. S. & Y. gate valve and shall be provided with a drain at the bottom. If the air vent is deemed desirable by the Inspection Department having jurisdiction, it shall consist only of a plugged outlet."

I believe this paragraph gives a very definite answer to all of our Hero's questions. The application is shown by Fig. 1.

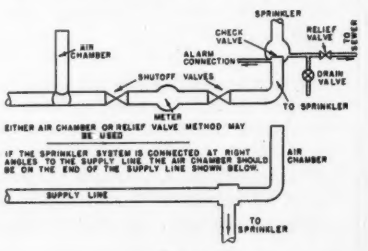

SPRINKLER
CHECK VALVE
RELIEF VALVE
AIR CHAMBER
ALARM CONNECTION
SHUTOFF VALVES
DRAIN VALVE
TO SPRINKLER
METER
EITHER AIR CHAMBER OR RELIEF VALVE METHOD MAY BE USED
IF THE SPRINKLER SYSTEM IS CONNECTED AT RIGHT ANGLES TO THE SUPPLY LINE THE AIR CHAMBER SHOULD BE ON THE END OF THE SUPPLY LINE SHOWN BELOW.
AIR CHAMBER
SUPPLY LINE
TO SPRINKLER

Fig. 1

SECOND PRIZE AWARD

Problem VI

By Frederick C. Ragg

Fair Lawn, N. J.

This is a case of a check valve being too good because it closes so thoroughly that all the surpressures coming from the supply line, are entrapped in the sprinkler system. A relief valve as suggested, would of course remedy the pressure buildup. This relief valve does not necessarily have to be installed near the check valve in the basement for it could be placed anywhere in the sprinkler system, near a drain pipe or a sink. On the other hand, however, this higher pressure, which reaches 135 lb. per sq. in. should not be alarming, it only looks odd to have two gages on the same system, showing different pressures. The sprinkler system, in all probability, will carry safely 150 lb. per sq. in. and as the primary purpose is to give fire protection, this duty is not in any way, impaired through the higher pressure. Therefore no remedy is needed.

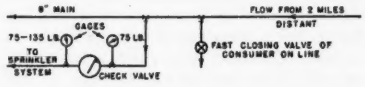


Fig. 2

If, for some reason, a solution must be found, then the present method of draining a few gallons at regular intervals, will serve the purpose. To install a small by-pass valve around the check would be another solution to overcome this nuisance. This by-pass could be opened from time to time, or even be left open, to relieve the excess pressure. A small pin-hole through the disk in the check, would also give the desired results. The insurance carrier, however, may object to these various makeshifts, for a number of reasons.

The cause of this pressure paradox is to be found ahead of the check valve in the street main. A series of causes can be advanced, but the largest increase is the result of water-hammer. On high pressure lines to water turbines special precautions are taken against the occurrence of these conditions because, with the large amount

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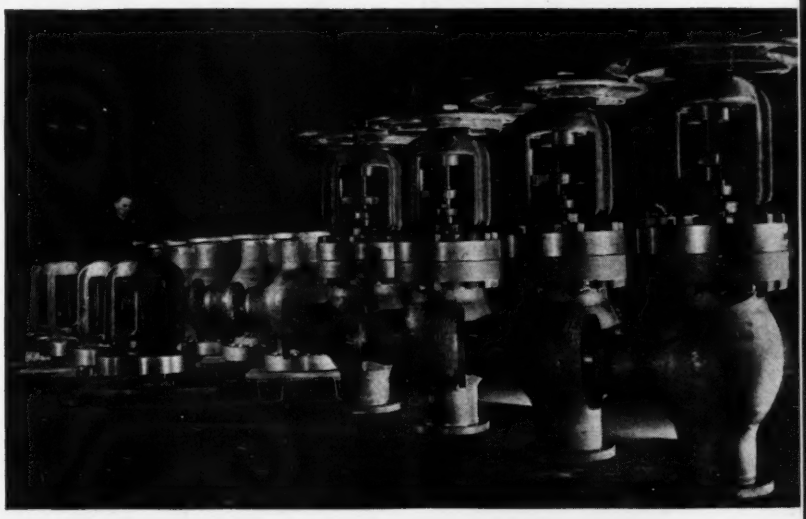


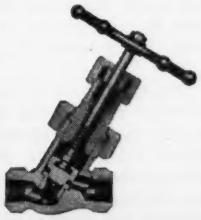
Above—Here are parts of nine (four fully assembled) 10 inch 1500 lb non-return valves with test flanges for the three new petroleum refinery plants powered by Pacific Gas and Electric Co. at Avon, Martinez and Oleum, California. Left — Stelliting forged steel disks for valves shown above in revolving, gas fired furnace, and, right — one of the body castings after shaking out of the foundry sand and before removing headers . . . pouring weight about 5000 lb per body.

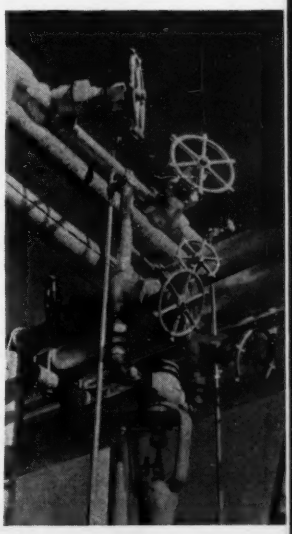
EDWARD MARINE VALVES ON FIRST STEAM "C2" SHIP

Edward steel valves went to sea on the SS Challenge. This was the first of six turbine drive ships of the Maritime Commission's "C2" class to leave the ways of the Federal Shipbuilding and Dry Dock Company. Equipped with Foster Wheeler boilers and General Electric turbines, the vessel was credited on its trial runs with a world's record in fuel economy for marine propulsion machinery. Boiler operating pressure is 450 lb per sq. in. and final steam temperature 750 F. Edward builds a wide range of cast and forged steel valves for marine steam generating systems.

FIND VARIED USES FOR EDWARD F. S. VALVES

F. S. of course means forged steel. As industrial chemists open startlingly useful fields of activity and petroleum technologists break new trails, no end of jobs for Edward forged steel valves appear. For high pressures and high temperatures, for corrosion resistance, stamina, long life and low overall cost, small valves of forged steel are usually best. Shown at left is Edward Fig. 2698 (inside screw), sister series to Fig. 2688 (OS&Y). The 1940 vintage, retaining the simplicity of design, tested materials, good workmanship, which have long made them a smart buy, tops all Edward valves that have gone before. Right — Easy operating Fig. 2698s, on refinery process lines.





EDWARD Valves

STOP • CHECK • BLOW-OFF • NON-RETURN
FEED-LINE • RELIEF • BLEEDER LINE • ETC.

of water at high velocity involved, the sudden closing of the control valve would result in pipe failure. The following example, the data for which are taken at random, may help to clarify the above statement.

Editor's Note: The balance of Mr. Ragg's letter has been omitted due to lack of space. In the example he calculates that in an 8-in. pipe line, 2 mi. long, a pressure of 272 lb. per sq. in. could be built up when a valve passing 4 sec. ft. was closed 6 sec. He makes no claim that this calculation represents actual conditions for many factors influence the final result. The calculation was included "merely to show where the pressure difference between the inlet and outlet side of the check . . . may come from."

THIRD PRIZE AWARD

Problem VI

By W. Freeman Smith
Danville, Ill.

There seems to be nothing phenomenal in the condition reported. Although the city water pressure is normally listed as 75 psi, if a recording pressure gauge were installed at this point it would undoubtedly record surges in pressure over a period of several days that would account for the increased pressure noted in the sprinkler system. We fail to believe that the temperature of the building if held within the limits claimed would be a significant factor; for if anything the increase in temperatures within the building would serve to expand in the pipes within the system which would meet, even offset any tendency of water to expand at such temperatures. So our thesis is that the pressure within the sprinkler system comes from momentarily increased water main pressure which is held in the system by a phenomenally good check valve, there being little air in the system.

Since many types of sprinkler systems use dry pipes instead of those suffused with water, as in this case, and are perfectly acceptable as to insurance rates, there can be no question about the wisdom of correcting the pressure differential by means of this simple changeover.

Before going into this further we are unable to withhold a question as to why this pressure worries any one. Insofar as we can tell it can have no adverse effect on the operation of the sprinkler mechanism. It has been our observation that check valves rarely hold water perfectly and sooner or later this one will clamp down on a minute obstruction and thus cause it to fail to seat so perfectly. Then these unequal pressures will cease as the water will bleed back to an equal main pressure.

But this is stated as a problem and cynics are brushed aside. Since the amount of water needed to equalize this pressure is small, and since pipes and fittings are expensive the simplest means is to use ⅜ in. pipe and fitting to form a by-pass around this check valve, locating in the by-pass a small adjustable pressure relief valve. When the pressure in the mains became higher than normal the pressure within the system itself would increase, but the instant this eased back to its rated amount the pressure relief valve would open, permitting the water to regurgitate as it were, to the main until closed off by the action of this small valve.

Piping made up thusly would not be adverse to insurance rates and in a closed system there is no danger of it flooding any floors; moreover, as there is no change for this water to become contaminated the water company could not object to this by-pass. The cost of such an alteration would be nominal.

GENERAL COMMENTS

The following letter by Mr. Nichols came in too late to be considered for the prize awards but covers the subject so comprehensively that it is reproduced in full.

By Prescott R. Nichols
Electrical Engineer
Municipal Light Department
Reading, Mass.

Conditions described in Problem 6 are practically always encountered in any automatic sprinkler system that is tight, that has a tight check valve on the supply connection and that is connected to a public water supply. The situation is normal and needs no remedy as both the piping and the sprinkler heads are fully able to withstand this pressure without injury. In fact the excess pressure will very slightly improve the snap action of the sprinkler head when it is opened by excess temperature as in the case of fire.

The excess pressure builds up for two reasons. The first, which, however, will account for only a small rise is due to temperature changes inside the building. When the temperature is low the air trapped in the ends of the branch lines will contract, thereby lowering the pressure and allowing water from the supply to enter. When the temperature rises the air expands and since the check valve is tight the water cannot escape and the pressure rises. After one cycle no more increase will result unless the temperature falls lower or rises higher than any previous time.

The main cause of the excess pressure is due to surges or water hammer in the supply system. These are always present to a greater or less degree and often build up considerable pressure in the system, particularly if the sprinkler system is at the end of a long supply line.

Speaking as a former fire insurance engineer I would not make any change in the system and would ignore the whole thing if the pressure did not exceed the figure given. If it goes any higher I would drill a $\frac{1}{16}$-in. hole through the clapper of the check valve which will permit the pressure to equalize on both sides of the check and yet will not interfere with the practical operation of the check valve. The writer neglected to state whether the check was an alarm check valve or not but it will make no difference.

If the check valve clapper is of iron, a brass plug should be inserted in the clapper and the $\frac{1}{16}$-in. hole drilled through this in order to prevent the hole filling up with rust and creating the original condition.

* * *

Howard J. Hassell of Salt Lake City believes the pressure rise is due to water hammer and offers as a solution the following: "The answer to the problem is very easy. Just make a *very slight* nick in the check valve seat. This will allow the pressure to equalize after each individual surge. The nick need not be large enough to interfere with the proper functioning of the check valve. In fact, a large percentage of such valves already leak sufficiently so that the condition here mentioned might never have been experienced."

On the other hand S. L. Krechefsky of Kansas City, Mo., feels that the trouble is due to temperature changes. He says: "It may appear, at first glance that the check valve should be removed. To do so would equalize the pressure in the line at the point where the two gages are connected, however, it would be contrary to the building

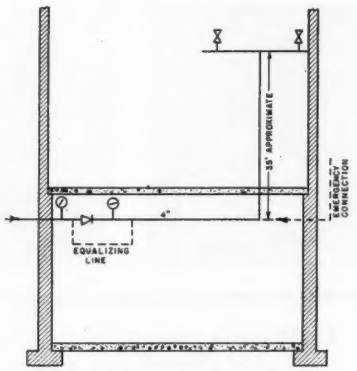


Fig. 3

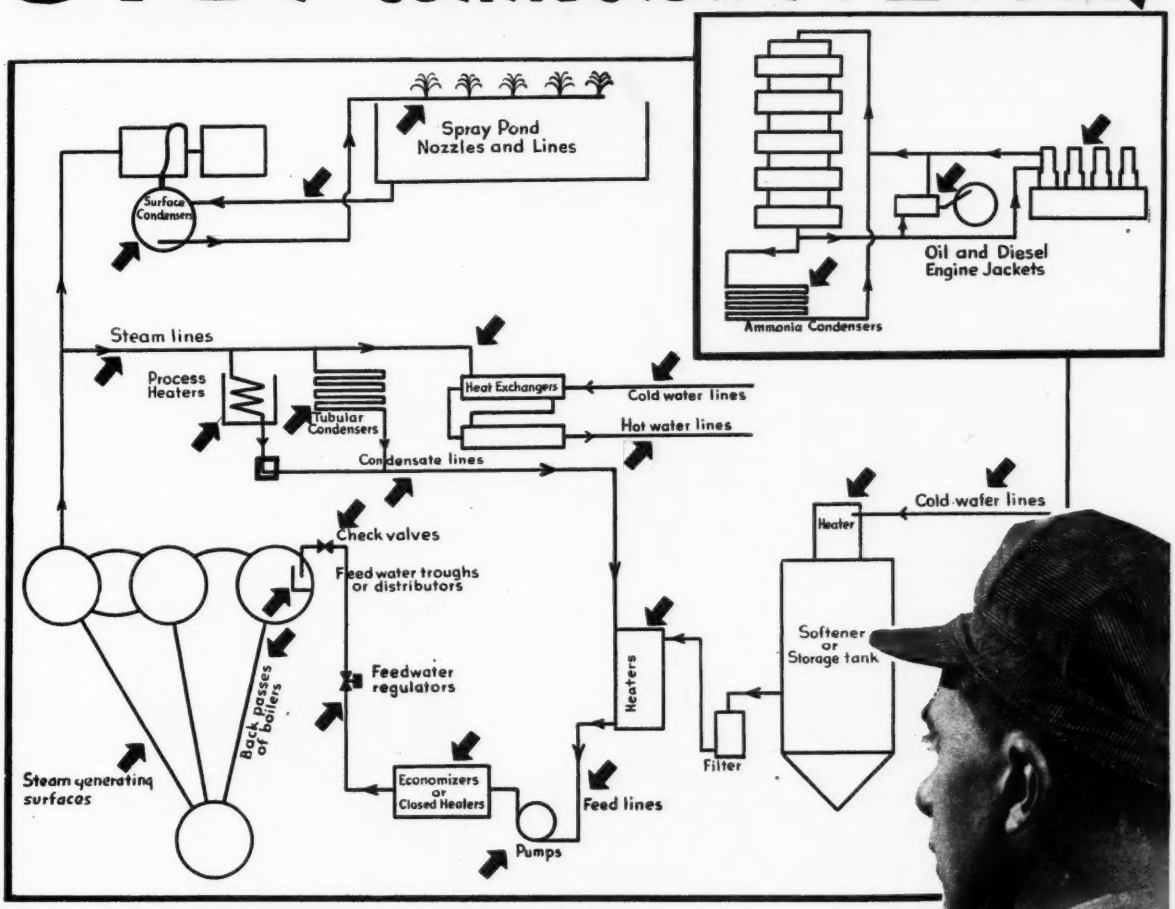
code requirements. In case of a serious fire, the sprinkler system is put into service and the header pressure drops which in turn necessitates the pressure pump carried by all fire fighting units to be connected up at the point indicated.

"Increase in pressure on the outlet side of the check valve is probably due to volumetric increase of water due to a change in temperature of the incoming water from about 40 to 80-90 deg. as stated.

"To remedy our hero's problem, we would install a small equalizing line between both sides of the check valve, say ¼ or ⅜ in. This would cause both gages to read the header pressure of 75 lb. In case of the fire department connecting their pump to the system, the small quantity of water which would pass through the equalizing line would not affect the header pressure."

Donald Osterhoudt of Poughkeepsie, N. Y., suggests a bypass valve and

STOP SCALE AND CORROSION HERE!



YOU know from experience that scale or corrosion, or both, can cause trouble in many places besides your boiler tubes and drums. But what you may not know is that Nalco offers service to prevent such trouble. Many Nalco customers are now taking advantage of this complete service. The advantages are obvious: (1) One responsibility for your entire plant. (2) Low combined cost. (3) Regular, systematic attention given to all of your problems. We will be glad to give you details on this *complete* treating service. *Write.* NATIONAL ALUMINATE CORPORATION, 6224 W. 66th Place, Chicago, Illinois.

ANY WATER NALCO SYSTEM ANY

Inquiries other than domestic, *except those from U. S. Possessions, Canada and Mexico*, should be addressed to ALFLOC LTD., Bush House, Aldwych, London, W. C. 2, Eng. Canadian inquiries should be sent to ALUMINATE CHEMICALS LTD., 372 Bay St., Toronto, Ont.

says: "The small valve should be of the Key Type, or one that can be locked in a closed position so that no unauthorized person can open it."

Walter J. Gorak, Chicago, Ill., says: "Without any great deal of expense on our Hero's part, would suggest installing a 'tee' on each gage line, and then connecting a small pipe (¼ in. is sufficient) from each 'tee,' to a small stop and check valve. In other words,

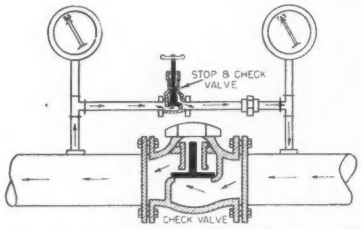


Fig. 4

by-passing the big check valve, without any unnecessary changes in your present set-up. This stop and check will release any higher pressure on the outlet side, back to the inlet, thereby equalizing the pressure at all times. It also can be left closed if so wanted, and opened at any time the pressure builds up."

Matthew W. Pawlowski, Philadelphia, Pa., feels that the pressure rise is due to contact with a steam pipe or perhaps a unit heater blowing directly on the water piping. He suggests the use of a bypass with a globe valve and mentions the possible effect of a gravity feed fire tank. "I'm taking the fire tank into consideration because sometimes the city pressure drops very low and, naturally, if this valve was left open the entire tank would empty back into the city mains, due to the fact that there would be a greater head pressure."

Elton Sterrett, Longview, Tex., considers both the temperature rise and water hammer and a slightly different arrangement of the bypass to prevent any considerable backflow. A portion of his letter follows:

"Regardless of the source of the pressure build-up, a simple change in piping, as sketched in Fig. 5, will provide for release of the increments as they occur, yet leave the sprinkler main protected by the check valve when conditions demand connection of outside water sources through the Siamese or other provision for water in case of main failure during fire.

"The main check valve, M, has a small bypass line connected around it, ¼-in. piping being adequate to care for most extreme variations. In this

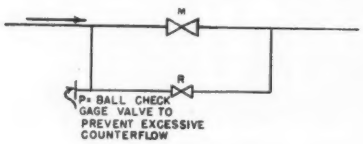


Fig. 5

bypass line is set another check, R, operating in reverse to the main check. In other words, relieving excess pressure beyond the main check to the line serving as supply source. Between this check and the 4-in. main line is set, in place of one of the ¼-in. ells, a ball-check valve, P, such as is used to cut off loss through a gage glass in case of breakage. The ball in this valve will not move under the minute flow required to equalize pressure increment beyond the main check, but will close positively and quickly if the normal water source be opened and pressure flow, as from pumper or fire engine, is set up on sprinkler system at any point beyond the bypass site.

"This equalizing bypass will function under pressure—or volume—increases too slight to be registered by the ordinary service gage, and will maintain ruling main supply pressure within the sprinkler system without attention, supervision or even infrequent juggling."

M. H. Werley, Ithaca, N. Y., says: "If 75 lb. per sq. in. is necessary at all times on the system the arrangement shown by Fig. 6 will be effective. This arrangement may be easily installed at little cost and is fool proof in that the system is operative even if spring load valve may become inoperative. This may be accomplished by opening and closing hand valves."

From Drummondville, Que., Canada, C. E. Olive also suggests the use of a relief valve in the bypass around the main check because "It . . . will not allow the sprinkler system to empty itself should there be any serious reduction in pressure in the main."

William Sheffer, Wingdale, N. Y., cautions that "it might be a good idea to look over the system carefully to make sure that it is not tied in with another source of supply or steam line —not likely but of course possible." Again Pulverizer Pete, the perennial contest runner-upper who had as usual all the answers, flower pots under the sprinkler heads, and fish swimming in the air chamber, points out in a very practical postscript: "There is also a chance that the inside gage is cockeyed and the pressure ain't building up."

In connection with the use of a relief valve for controlling the pressure increase, Charles Hubbard, San Francisco, Cal., says, "A relief valve in the basement would *not* pass an insurance inspector, but there should be no objection to a relief in a high part of the sprinkling system."

Many considered the trouble to be due entirely to thermal expansion and supported their conclusion by detailed calculations reaching the general conclusion that the system could not be entirely filled with water or the expansion would have caused a rupture of the system. The following reply from C. O. Sandstrom is typical of this group:

"Evidently our Hero's trouble in Problem No. 6 is due to the rise of

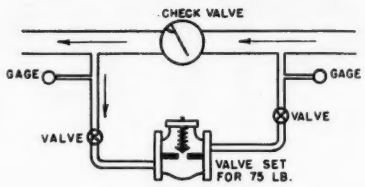


Fig. 6

temperature and resulting expansion of the water in the piping. Assuming the original temperature of the water entering the building as 50 deg., a rise to 85 deg., would increase its volume about 2 per cent. If the pipe walls were rigid, and there was no air trapped in the piping; that is, no provision for elastic yield to the expanding water, the increase of pressure, assuming a modulus of elasticity of the water of 300,000, would be $0.02 \times 300{,}000 = 6{,}000$ psi. But the pressure rising to only 135 psi indicates the existence of the factors mentioned—elastic walls and trapped air.

"The small amount of trapped air being as effective as indicated in the foregoing, implies that a greater amount would be still more effective, and suggests a remedy—install one or more vertical 'dead ends' in the piping system; that is, air-chambers. The volume of the chamber, or chambers, need not exceed 1 per cent of the volume of the 4-in. header to produce a great reduction of the pressure of the expanding water. Of course, some of this air will be 'absorbed' by the water as the pressure rises, and emitted as the temperature rises; but since the water is held in the system by the check-valve—there is no discharge and replenishing of the water—there will be no actual loss of air."

Of course not all of the group agreed with Mr. Sandstrom in detail and the calculated volume of the necessary air chamber ranged from 1 per cent as given above to 10 per cent as calculated by Julius Brodsky, Rochester, N. Y. S. L. Gunderson, chief engineer, Wheaton College, Wheaton, Ill., suggests 20 to 30 gal. capacity; James A. Liccardi, Cleveland, O., 20 gal. made from a 3½-in. length of 12-in. pipe.

This cushion tank on the sprinkler side of the system is a remedy and its function is entirely different from the air chamber on the inlet side of the check valve. The sprinkler system itself may be used as suggested by R. Williamson, Newton Center, Mass., who says:

"If the system is the usual type with gate valve outside the check valve, draw off inside the check valve and a test connection at the top of the riser, the simplest way to prevent recurrance of excessive pressure would be to thoroughly drain the system and refill. This will trap sufficient air in the branches, which are pitched upward from their connection to the riser, to provide a pneumatic cushion and prevent wide pressure fluctuations."

Fig. 2129
Single Wedge Disc
Non-rising Stem

Fig. 2125
Double Wedge Disc
Rising Stem

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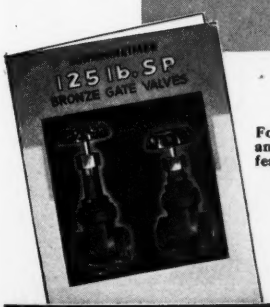

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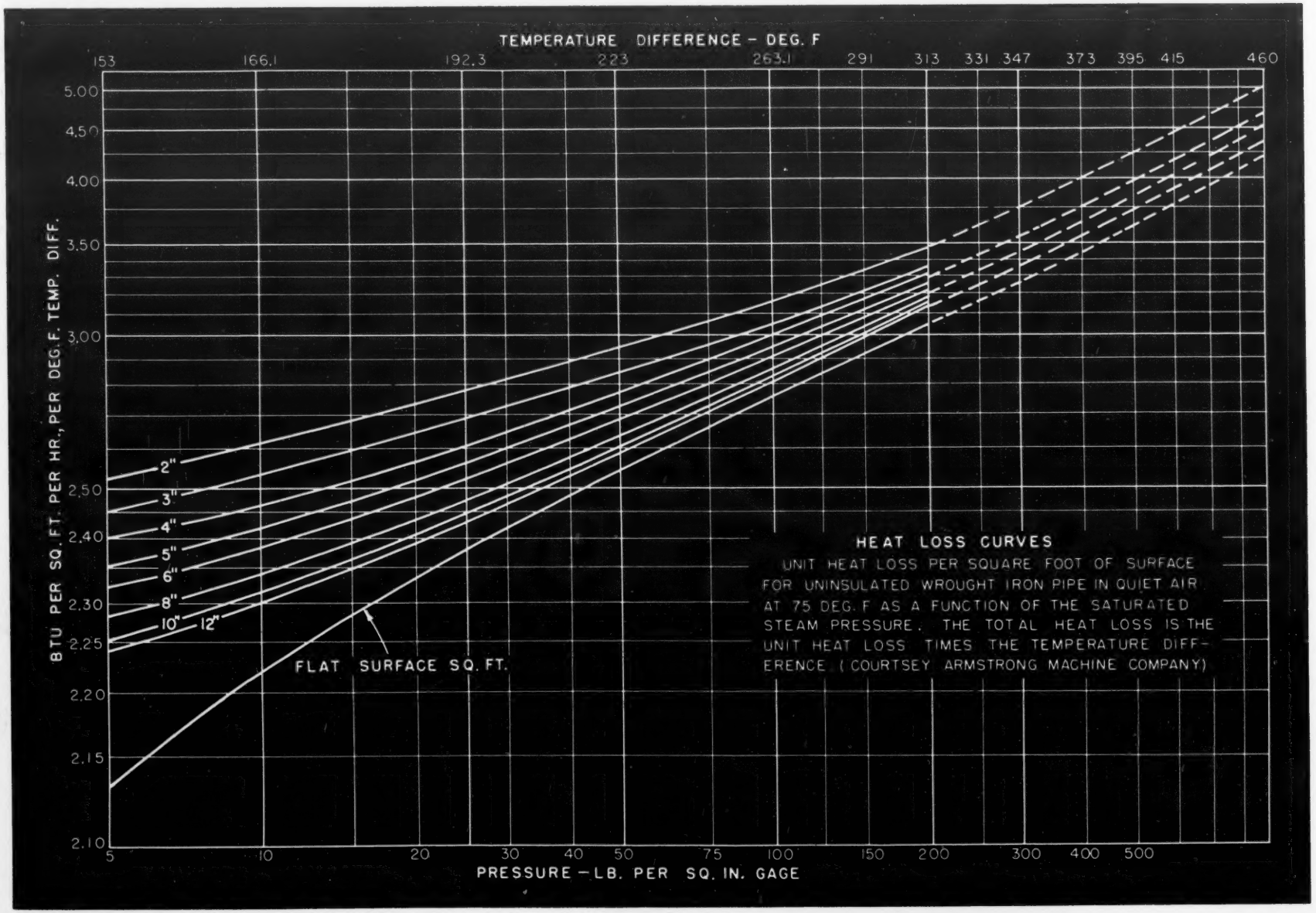
TEMPERATURE DIFFERENCE – DEG. F
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FLAT SURFACE SQ. FT.
HEAT LOSS CURVES
UNIT HEAT LOSS PER SQUARE FOOT OF SURFACE FOR UNINSULATED WROUGHT IRON PIPE IN QUIET AIR AT 75 DEG. F AS A FUNCTION OF THE SATURATED STEAM PRESSURE. THE TOTAL HEAT LOSS IS THE UNIT HEAT LOSS TIMES THE TEMPERATURE DIFFERENCE (COURTSEY ARMSTRONG MACHINE COMPANY)
5
10
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PRESSURE – LB. PER SQ. IN. GAGE

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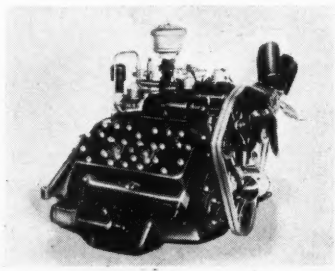
THE EP Series air motors, developed by Thomas C. Wilson, Inc., are six bladed and of the two cylinder type. The power developed is appreciably increased because of the six overlapping power impulses per revolution and the reduction in internal air losses, the latter also reducing air consumption.

A unique method of introducing the air into the cylinders also assures positive starting, high torgue and the elimination of sticking due to the incoming air holding the blades in close contact with the cylinder wall. A substantial, permanent seal between the intake and exhaust areas of opposing cylinders insures the continuance of original efficiency. Cooler operation and increased overall efficiency result from the use of generous exhaust passages which reduce back pressure to the minimum.

Self-propelled Air Compressors

SCHRAMM INC., West Chester, Pa., has recently developed one of the standard small air compressors for replacement of standard Ford V-8 engines in Ford Trucks or other similar applications. The Ford engine is removed from the truck and a combined engine and air compressor is replaced under the hood of the truck. No payload space is taken up by power take-off and compressor on the rear of the truck, and the truck uses the same engine power cylinders for power for propulsion and for driving the air compressor. By merely manipulating several controls in the cab of the truck the unit is converted from an air compressor to a truck and vice versa without even stopping the engine. The unit delivers 55 cu. ft. of air per minute at 100 lb. pressure.



Basically the unit is a four cylinder engine and a four cylinder air compressor in an eight cylinder block. When operating as a truck the four power cylinders drive the truck through the standard Ford clutch and transmission and the four compressor cylinders are shut-off so that no power is consumed and no air is compressed. This unit is so flexible that it can be adapted to any sort of installation whether self-propulsion is desired or not.

Photo-Electric Colorimeter

A PHOTO-ELECTRIC colorimeter incorporating a number of distinctive features is being marketed by Dr. F. Loewenberg, 10 East 40th St., New York City. This instrument permits the use of a great variety of sample holders and light filters and covers a wide range of application, ranging from simple measurements of light transmission of liquids to colorimetric and turbidimetric chemical analysis and to abridged spectrophotometric determinations.

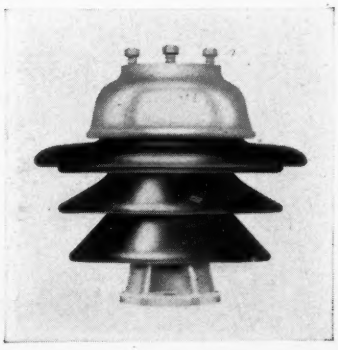
The "Lumetron" colorimeter uses two blocking-layer photocells in a balanced circuit which makes it possible to operate the instrument from the power lines without the use of batteries or constant-voltage transformers. Line voltage changes do not affect the reading.

The colorimeter is made in four standard models. For general purposes the instrument is furnished as a self-contained unit with built-in pointer galvanometer. Another model designed for abridged spectrophotometric analysis is equipped with an especially powerful light source and a high sensitive mirror galvanometer so as to allow the use of monochromatic filters. A third model is designed for the accurate measurement of almost colorless liquids and a fourth combines the monochromatic feature and the long sample holder. The instrument is provided with a concentrated filament bulb which provides the illumination for the optical system. The intensity of the lamp is controlled by means of a rheostat. By operating a key switch the electrical circuit is changed so that the intensity of the light incident upon the cell can be read directly on the galvanometer. In this way it is possible to allow not only for changes in light output of the lamp but also for the light absorption of the filter which is used in each case.

Special attention has been paid to the reduction of the influence of thermal effects upon the photocells. A wide range of filters is available for use with the instrument and special models can be furnished with built-in range switches to spread the dial readings over any desired limited transmission range.

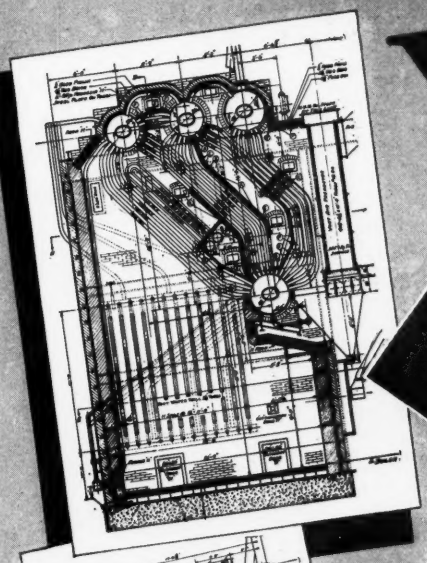
Switch and Bus Insulator

PORCELAIN PRODUCTS, INC., Parkersburg, W. Va., announces a new line of switch and bus insulators which are assembled with a new asphaltic compound known as Permalastic compound.



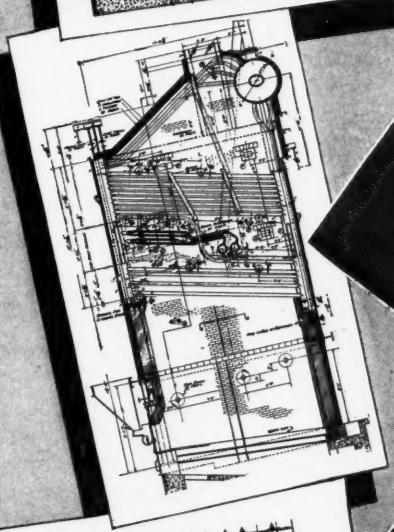
It is permanently elastic and has a high softening point, as well as high elasticity at low temperatures. The line covers all standard N.E.M.A. units, as well as several special units. All units are available with either radio interference treated or standard glaze.

Vogt



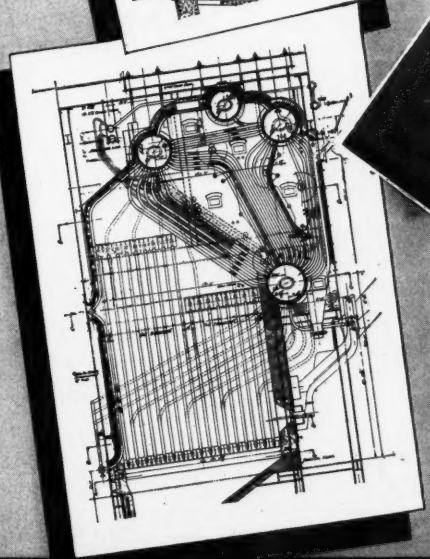
KIMBLE GLASS COMPANY, VINELAND, N. J.
30,000 lbs. steam per hour Vogt LE type bent tube Unit. Furnace arranged for pulverized fuel. Front and side water wall tubes. Vogt Air Preheater. Design pressure 175 lbs.— Total steam temperature 490 degrees F.

Water Tube



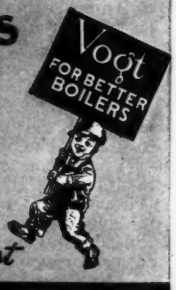
IN A LARGE MID-WESTERN POWER PLANT.
80,000 lbs. steam per hour Vogt sectional header type Unit. Spreader stoker using lignite. Present operating pressure 225 lbs.—Total steam temperature 522 degrees F. Design pressure 400 lbs. — Total steam temperature 700 degrees F.

BOILERS



CLEVELAND WORSTED MILLS CO., CLEVELAND, O.
90,000 lbs. steam per hour Vogt M type bent tube Unit. Pulverized fuel. Water wall tubes. Present operating pressure 150 lbs.—Total steam temperature 515 degrees F. Design pressure 616 lbs. — Total steam temperature 750 degrees F.

BENT TUBE SECTIONAL HEADER AND BOX HEADER TYPES
For Any Fuel

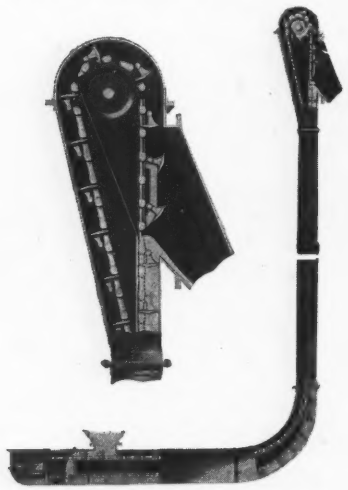


Bulletins on Request

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.
NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

Elevator Conveyor

THE MASS-FLO elevator-conveyor announced by The Jeffrey Mfg. Co., Columbus, Ohio, offers a low-cost and unique method of handling all kinds of granular materials. It is simple in design and construction, consisting of a



steel casing through which solid pivoted flights spaced at intervals of a single strand of chain move the material horizontally or vertically in a solid mass or with partial load. Discharging of the load is done by means of a tripper. Fed or discharged at any point, this elevator-conveyor handles material with very little agitation, thus breakage and degradation are practically eliminated.

Wire Stripper With Vacuum Collector

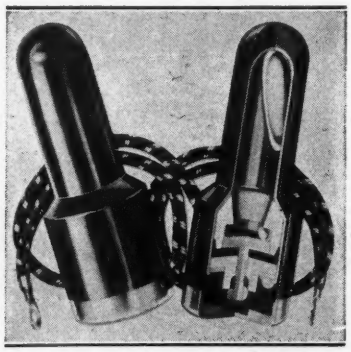
A NEW, lower cost, power-driven, brush-type Wire Stripper, known as the Ideal 9-C Model, is announced by the Ideal Commutator Dresser Co., 1033 Park Avenue, Sycamore, Ill. This new unit greatly speeds up production work in stripping wires. A vacuum attachment draws the insulation materials into a drawer in the base of the unit, thus eliminating dust and dirt of stripping

operations. The Stripper strips cotton and enamel, silk and enamel, string asbestos and other light insulations from round, flat or rectangular solid or stranded wire. It is especially effective in cleaning fine "Litz" wires, in removing gummy insulation imbedded in stranded wires and in cleaning the new "Formex" magnet wire.

Operation of the new wire stripper is by single, direct-belt drive from the ¼-hp. motor to the special steel wire brushes. The speeds of the brushes are synchronized through an auxiliary, flat-belt drive which also operates the vacuum exhaust.

Metal Mercury Switch

DURAKOOL, INC., Elkhart, Ind., announces the silent unbreakable, non-inflammable Durakool Metal Mercury Switch, and its new double reduction.



The two reducing agents prevent deterioration of the mercury, increase the efficiency and reliability in operation and assure long uninterrupted life of the switch. They withstand temporary short circuits and operate with small tilt and require remarkably little energy. This mercury switch allows many new applications, from wall switching to motor starting.

High-Pressure Valve

THE HANCOCK VALVE DIVISION of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a type of steel valve called the Hancock No-Bonnet-Joint valve which was developed to end leakage through the gasket joint between the valve body and bonnet at elevated pressures and temperatures. These are made for pressures up to 2500 lb. at 1000 deg. F. in one basic size and then tapped, or bored for welding, for ½, ¾ and 1 in. pipe.

When a No-Bonnet-Joint is welded in the line, the only joint is that of the stuffing box for the stem. The valve

may be easily disassembled in the line for regrinding. Its Stellite seat is welded to the valve body and is an integral part of it. The valve disc is also heavily Stellited to resist wire-drawing and wear.

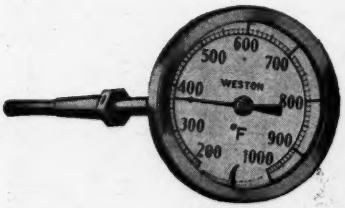
General-Purpose Oil Window

BIJUR LUBRICATING CORP., Long Island City, New York, has developed a new sight oil window which is offered for general use in connection with oil reservoirs, containers and lubricators.

This window assembly consists of ring (chromium plated, with polished face pressed flush), window, gasket, and cup, all fitted snugly into a metal pocket. A drilled opening at top of cup, and one at bottom, permit free passage of the oil. The bright aluminum background of the cup acts as a reflector which gives sharp visibility of the oil level, even with imperfect lighting. Standard sizes of the window, specified according to the diameter of aluminum reflector face, are ¾, 1-1/16, and 1-5/16 in.

Stack Thermometer

A NEW stack thermometer has been introduced by Weston Electrical Instrument Corp., Newark, N. J. Flue gas temperatures can easily be measured by fitting this all-metal thermometer into a sleeve holder which holds the thermometer stem in a horizontal position in the center of the flue gas stream. Completely enclosing the temperature-sensitive element, the stem is 9 in. in. length. A shatterproof scale glass is employed. The temperature range is from 200 to 1000 deg. F.

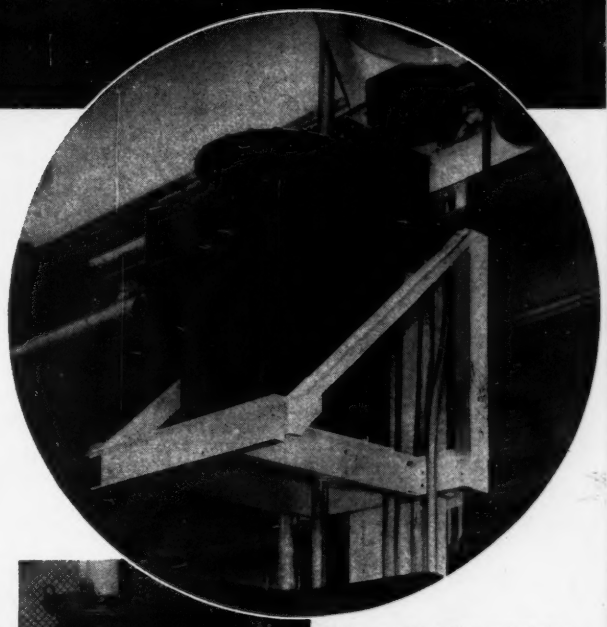


Installation is extremely simple as it is only necessary to drill a 5/16 in. hole in the pipe, insert the tapered sleeve holder until it fits tight, and then slip the thermometer stem through the sleeve. For accurate measurement, it is only necessary that 4 in. of the stem be inserted in the gas stream.

G-E Pyranol Transformers

Offer NEW SOLUTIONS

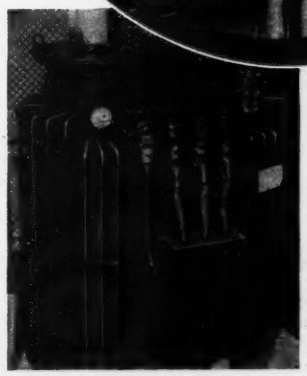
to Many Factory and Commercial Distribution Problems



PROBLEM 1
MODERNIZATION OF FACTORY LIGHTING

In one case, the engineers were asked to increase lighting levels on a factory floor to between 25 and 35 foot candles. The existing lighting circuit, which was 600 feet long, ran from a substation outside the building. To handle the increased lighting load with old methods would have required a new and larger transformer outside the building and new and larger secondary copper inside. Pyranol transformers provided a new solution to this problem that utilized the existing wiring and resulted in savings of 40 per cent.

The old wiring was split into three sections, and a small Pyranol transformer was installed at the center of each section. The expense of running new secondary copper was avoided; voltage regulation was better and power losses lower than they would have been on the long circuit.



Up near the ceiling, out of the way, is one of the Pyranol transformers that made possible savings of 40 per cent in the cost of modernizing a factory lighting circuit

PROBLEM 2
AIR CONDITIONING IN OFFICE BUILDINGS

The installation of air-conditioning equipment in buildings frequently presents a problem in power distribution that can be answered economically by Pyranol transformers. The Pyranol transformer shown at the right is installed on the third floor of the Equitable Building in Des Moines, Iowa, to supply an air-conditioning load on that floor. Because Pyranol is noninflammable, the transformer could be installed without a vault, at a convenient location near the load center.

Greater safety, plus savings in the over-all cost of transformer installations, makes Pyranol transformers the most practical and economical transformers for office buildings, theatres, hospitals, and other public buildings

PROBLEM 3
POWER FOR CONCENTRATED FACTORY LOAD

Welding machines in the Pittsfield Works of General Electric required power at 575 volts. Floor space was at a premium, and this fact made it impracticable to build a fireproof vault near the load center and install oil-filled transformers. Pyranol transformers—three of them, each rated 635 kva, 13,800 v—provided the answer and reduced the over-all costs of the installation.

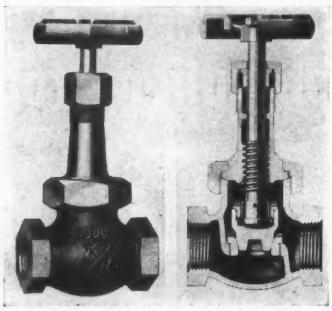
For your installations, it will pay you to investigate the possibility of savings with Pyranol transformers. Ask your G-E representative for complete information, or write for Bulletin GEA-2637. Address General Electric, Dept. 6B-201, Schenectady, N. Y.

GENERAL ELECTRIC

200-71

Valves for Throttling Service

THE KENNEDY VALVE MFG. CO., Elmira, N. Y., announces a new line of bronze globe and angle valves with plug-type discs and renewable seat rings for close control in throttling service and for general heavy duty. These valves are made in sizes from ¼ to 2 in. for 200 lb. steam at 550 deg. F. and 400 lb. cold water, oil, or gas, non-shock; and in sizes from ¼ to 3 in. for 300 lb.



steam at 550 deg. F. and 600 lb. cold water, oil or gas, non-shock. The plug type disc and renewable seat ring are both of copper-nickel alloy, the seat rings being made of a harder composition than the disc. The stems have 60,000 lb. per sq. in. tensile strength with acme standard threads, and have rounded stem head to permit self-centering of the disc. The bonnets are provided with particularly heavy union bonnet rings, and have machined seat on the under surface to permit repacking under full line pressure when the valve is wide open.

A. C. Electrolytic Motor Starting Capacitors

THE TYPE ETN A.C. electroyltic capacitors made by Cornell-Dubilier Electric Corp., South Plainfield, N. J., are of the etched-foil type, hermetically sealed in cylindrical aluminum containers with Bakelite terminal heads into which aluminum stud inserts are moulded, and which also include safety vents to take care of excessive internal pressure resulting from accidental or abnormal conditions. In addition, each unit is jacketed with a specially treated cardboard sleeve of high electrical insulation qualities and moistureproof. These standard units are available with rated working voltages of 110, 125 and 220, 50-60 cpcles, and in a wide variety of capacities ranging from 10 to 498 mfd. Sizes vary from 1.425 in. diam. by 2⅞ in. long for the lowest capacity, to 2.55 in. by 4½ in. for the largest unit. Metal end caps increase these diameters ⅛ in. and lengths 1⅛ in.

Vernier-Control Variable Speed Transmission

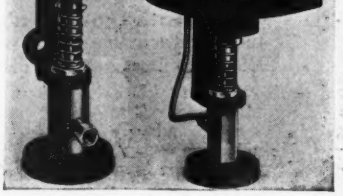
LINK-BELT CO., Philadelphia, Pa., announces that it is now in position to equip all sizes of the Link-Belt P.I.V. Gear variable speed transmission with vernier control which can be supplied with either one of two ratios—7½ to 1 or 30 to 1, and is equipped with two hand wheels. One is for direct control; the secondary, or vernier type control hand wheel will provide either 30 turns or 7½ turns to one of the direct wheel, depending upon which ratio of worm-gear reduction set is furnished.

The sensitivity of this control makes it particularly applicable for such services as: synchronizing the speeds of two machines; justifying for shrinkage and expansion of such products as textiles and paper; controlling feeders; on weighing operations; obtaining exact register; controlling the overlay of wire-covering on wire producing machinery.

Hydraulically Operated Lubricators

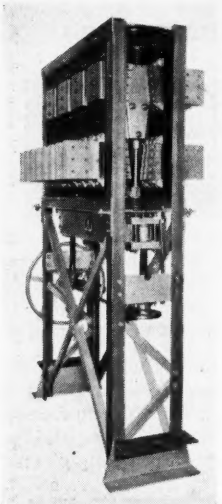
BIJUR LUBRICATING CORP. announces new types of automatic lubricators with no mechanical drive connection between machine and lubricator pump. In place of the driving mechanism, a small diameter tube (5/32 in. O.D.) is connected between the machine hydraulic system and the pump used for feeding oil to the various bearings. This method has a distinct advantage is giving maximum flexibility in design, as the pump can be located at the most convenient point, independent of any consideration as regards drive.

The hydraulic lubricator pumps illillustrated are of two distinct forms: Type "C," arranged for mounting on a standard two-pint or six-pint oil reservoir; and Type "G" particularly adapted to mounting in a reservoir cast integral with the machine.



Switch for Furnace Transformer

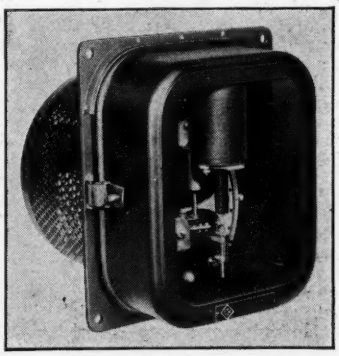
TO MEET the demand for high ampere switches on electric furnace transformers, this unique design has been developed by Delta-Star Electric Co., Chicago, Ill.



Double-throw, it permits easy and rapid switching of an eight-coil furnace transformer without changing heavy cables. The series-parallel interconnections are completely factory assembled, so switch can be connected directly to transformer leads.

Voltage Regulator

ALLIS-CHALMERS MFG. CO., Switchgear Division, Milwaukee, Wis., has just announced its new type V-11, Rocking contact voltage regulator for control of small a.c. and d.c. generators. There are no vibrating contacts, tubes or other parts requiring replacement or readjust-



"POWELL IRON BODY VALVES"

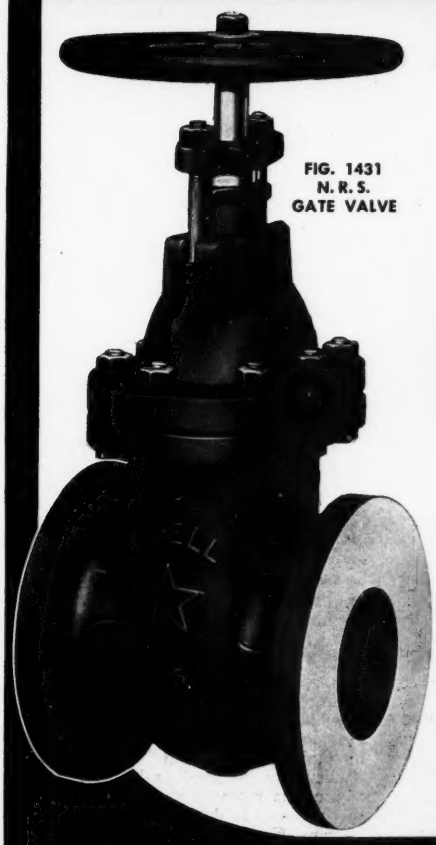


FIG. 1431
N. R. S.
GATE VALVE

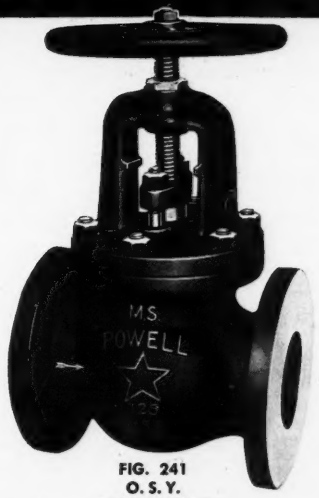


FIG. 241
O. S. Y.
GLOBE VALVE

FIG. 1444
O. S. Y.
GATE VALVE

Painstaking Powell workmanship teamed with constant design improvements and inspection of materials — means that Powell Iron Body Valves meet the most critical service tests.

Be sure of dependable valve performance! For unusual service, minimum upkeep, specify Powell Valves.

POWELL VALVES

THE WM. POWELL CO. CINCINNATI, OHIO

ADVERTISING PAGES REMOVED

ment at frequent intervals. The enclosing case excludes dust and foreign matter, thereby reducing maintenance. Only two simple adjustments need be made at the time of installation, since all major adjustments are made at the factory.

Due to the rocking contact principle incorporated in the type V-11 regulator, it is extremely quick acting since it regulates the voltage by directly varying the resistance in the exciter field circuit. The type V-11 regulator consists of a sensitive solenoid actuated plunger which acts upon a main shaft, rocking a special contact sector over the inner surface of a commutator, the segments of which are connected permanently to the regulating resistance. The segments are heavily silver-plated in order to insure positive contact surface, and are insulated one from another and solidly held in place on a specially constructed base to prevent any disalinement through years of service.

News from the Field

In a recent announcement it was stated that effective in January, the entire Unit Heater & Cooler Co. manufacturing and sales setup was taken over by D. J. Murray Mfg. Co., Wausau, Wis., the parent company. This move was made so that manufacturing and sales of the company's products may be continued in a larger and more effective way. The Unit Heater & Cooler Co. was established in 1929 by D. J. Murray Mfg. Co. as the sales organization. The new arrangement the manufacturer states will result in more concentrated and extensive efforts on the behalf of their entire line of heating and cooling products, and will consolidate and improve engineering, manufacturing and sales staff more closely. The D. J. Murray Mfg. Co. management states that several new projects and items are now in the making which will be announced at a later date.

Manning, Maxwell & Moore, Inc., has announced the advancement of Louis H. Brendel from the position of assistant sales manager of the Hancock Valve Division to assistant to the general sales manager, in which position he will have supervision of sales promotion for the Ashcroft American Gauge Div., the Consolidated Safety Valve Div., the American Schaeffer & Budenberg Instrument Div. and the Hancock Valve Div.

A. J. Wadhams, vice president and manager of the Development and Research Division of The International Nickel Co., Inc., has announced the addition of Dr. William A. Mudge to the Technical Service Division of the New York office.

Convention dates for the Society of Automotive Engineers meetings have been announced as follows: March 14-15, National Aeronautic Meeting, Washington Hotel, Washington, D. C.; March 28-29, National Transportation and Maintenance Meeting, Mellon Institute Auditorium, Pittsburgh, Pa.; June 9-14, Summer Meeting, The Greenbrier, White Sulphur Springs, W. Va. Additional details may be obtained from the secretary of the Society, John A. C. Warner, 29 West 39th St., New York city.

The Terry Steam Turbine Co. announces the appointment of Roger C. Jones, P. O. Box 1421, Hartford, Conn., as sales representative for the state of Connecticut.

Consumers' Council Division has been changed from an independent agency to the Department of the Interior, under Nathan R. Margold, Solicitor of the Department. Appointment of Paul Sifton as assistant director is announced, a transfer from the Wage and Hour Administration.

At a recent board meeting of the Westinghouse Electric & Mfg. Co. George A. Blackmore, president of the Westinghouse Air Brake Co. of Pittsburgh and of the Union Switch & Signal Co. of Swissvale, and Arthur W. Page, vice president and director of the American Telephone & Telegraph Co. of New York, and a director of the Continental Oil Co. were elected as directors of the Westinghouse Electric & Mfg. Co.

Herbert M. Orschel has joined the Perolin Company of New York as sales manager for their Central Division territory with offices in Chicago. Mr. Orschel has had a wide range of experience, having been associated with Johns-Manville for many years as a branch manager, with Mohawk Asphalt Heater Co. as general sales manager, with Aeroil Burner Co. as field sales manager and with the American Asphalt Paint Co. as district sales manager. The Perolin Co. of New York is the Sales Division of The Perolin Co. of America pioneers in water and metal treatments and specialties.

Worthington Pump & Machinery Corp. announces the appointment of Harold W. Stoddart to the positioin of manager of its Turbine Well Pump Division.

W. H. Mark Hanna, director of the Michigan State Efficiency Engineering Division, Lansing, Michigan, reports that the division is revamping its catalog files and is interested in receiving the latest trade literature dealing with heat, light and power equipment; materials and supplies; and general specifications and discount sheets.

Dr. John W. Finch has submitted his resignation as director of the Bureau of Mines to take effect January 31, the purpose of resuming his practice as a mining engineer, in which he was engaged prior to assuming the directorship of the Bureau of Mines.

Announcement has been made by the American Institute of Electrical Engineers that the Westinghouse Electric & Mfg. Co. has set up a $25,000 trust fund to provide graduate fellowships in electrical engineering. Known as the Charles LeGeyt Fortesque Fellowship, the educational trust was established as a memorial to Dr. Fortesque "in recognition of his valuable contributions to the electric power industry." His outstanding achievements were his development of symmetrical coordinates, his work on transformer design, and his theories of lightning behavior. Dr. Fortesque was graduated from Queens University, Kingston, Ontario, in 1898, as the school's first electrical engineer. Prior to his death, December 4, 1936, he was the recipient of 185 patents for electrical inventions achieved during his 38-year association with the Westinghouse company.

John I. Yellott has been appointed professor and director of mechanical engineering at Armour Institute of Technology, according to an announcement by H. T. Heald, president. The appointment will become effective as of the first of September, 1940, concurrent with the beginning of operation of the new Illinois Institute of Technology — the new engineering school brought about by the merger of Armour and Lewis Institute. Mr. Yellot, who comes to Armour Institute from Stevens Institute of Technology, will assume the duties of the position left open by Prof. P. C. Huntly—the latter was relieved of his duties as head of mechanical engineering so as to be able to direct the activities of the civil engineering department. Mr. Yellot is an honor graduate from Johns Hopkins University in 1931, where he also received a Master's degree in 1933, after two years of advanced study under Prof. A. G. Christie. For one year he was instructor in mechanical engineering at the University of Rochester, and in 1934 he came to Stevens, where he is now assistant professor, engaged in teaching steam power, thermodynamics, and heat transfer. He served as chairman of the Mechanical Engineering Department at Stevens in 1937-38.

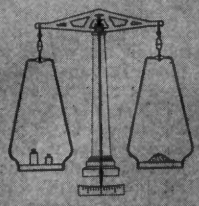
The Annual Meeting of the National District Heating Association will be held at French Lick Springs Hotel, French Lick, Indiana, May 14, 15, 16 and 17, 1940.

Colonel W. F. Rockwell, President of Pittsburgh Equitable Meter Company, and Chairman of the Board of the Standard Steel Spring Company, in a report to stockholders stated that employment in plants scattered throughout the country has reached a peak of close to 8000 men. Some of these plants have backlogs which more than cover six months' operations.

These beneficial results are ascribed largely to a consistent program of scientific research and development. In addition to company operated laboratories, in which over one hundred engineers are constantly employed, fellowships are maintained at Mellon Institute where particularly involved problems requiring continuous research are handled. One of the outstanding developments in the past year is Corronite which is a metallic pore-free coating, offering exceptional advantages in corrosion resistance. Extraordinarily thin coatings produced by this process have been found to give effective protection against corrosion of a severe type and the bond to the steel is so firm and ductility of the coating so high that bending or forming does not impair the protective value of the

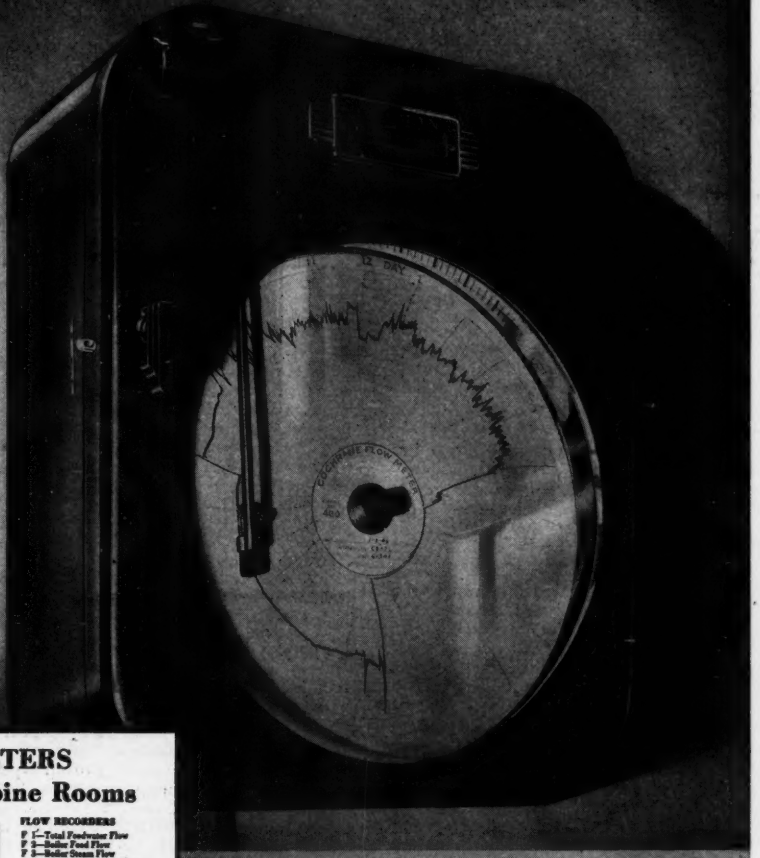
COCHRANE FLOW METERS

For Every Type of Fluid Flow Application

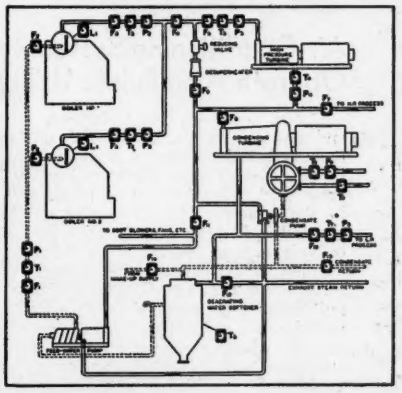


THE GALVANOMETER NULL BALANCE

The unusual accuracy and dependability of the Cochrane Electric Flow Meter result from its galvanometer-null principle of operation, which insures registration with extreme sensitivity and without lag or hysteresis.



COCHRANE FLOW METERS as applied to Boiler and Turbine Rooms



FLOW RECORDERS
F 1—Total Feedwater Flow
F 2—Boiler Feed Flow
F 3—Boiler Steam Flow
F 4—Total Boiler Steam Flow
F 5—H.P. Turbine Steam Flow
F 6—Superheater Steam Flow
F 7—H.P. Process Steam Flow
F 8—L.P. Turbine Steam Flow
F 9—Circulating Water Flow
F10—L.P. Process Steam Flow
F11—Auxiliary Steam Flow
F12—Exhaust Steam Return
F13—Condensate Return
F14—Make-up Water to Softener

TEMPERATURE RECORDERS
T1—Feedwater Temperature
T2—Boiler Steam Temperature
T3—H.P. Turbine Steam Temperature
T4—Steam Temperature from H.P. Turbine
T5—Inlet Water Temperature to Condenser
T6—Outlet Water Temperature from Condenser
T7—L.P. Process Steam Temperature
T8—Pumped Water Temperature

PRESSURE RECORDERS
P1—Feedwater Pressure
P2—Boiler Steam Pressure
P3—Steam Pressure to H.P. Turbine
P4—Steam Pressure from H.P. Turbine
P5—Process Steam Pressure

LIQUID LEVEL RECORDERS
L1—Boiler Water Level

Cochrane offers a complete line, with flow meters suitable for every type of plant application. Cochrane Flow Meters measure and record the flow of: STEAM, for boiler output, distribution, turbine consumption, process and heating; WATER, for boiler feed input, pump discharge, condensate, well delivery, effluent and condenser circulation; AIR and GAS, for compressor discharge, output and process; MISCELLANEOUS LIQUIDS and GASES, such as sewage, brine, oil, caustic soda, ammonia, oxygen, hydrogen, etc.

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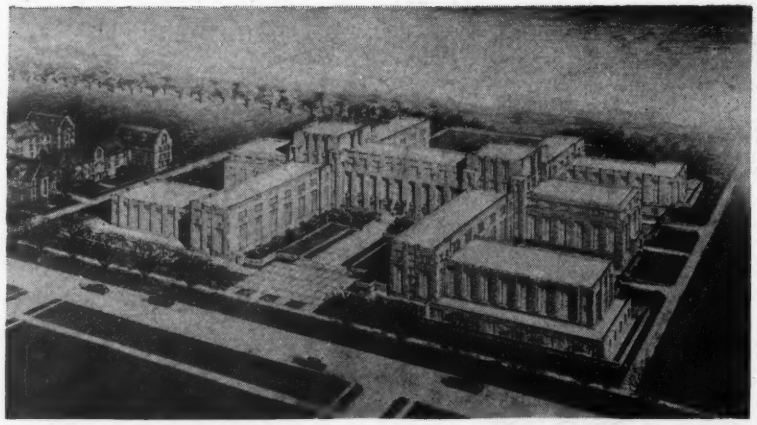
COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • FILTERS • BLOW-DOWN EQUIPMENT • VALVES • FLOW METERS



coating. Another development is a series of plastic metallic lubricants for use at very high temperatures and pressures. These lubricants have many applications in industry and promise results in the creation of an entirely new industry.

PITTSBURGH PIPING & EQUIPMENT Co., Pittsburgh, Pa., announces the appointment of Roy W. Emerson as metallurgist and special welding engineer. He will be in charge of the metallurgical laboratory and will supervise all welding procedure and welding personnel.

ABOUT $4,000,000 was involved in the purchase of the Kollsman Instrument Co. by the Square D Co. Acquisition of Kollsman gives Square D a greater diversity of product, a broader market and an opportunity to apply the precision ideas of Paul Kollsman to its general line of equipment.

The Kollsman organization will remain intact and the equipment marketed as heretofore but Square D expects that some of the principles and devices will fit into present and future development in its present lines and will be marketed through the Square D sales organization. At present Kollsman's manufacturing will remain at the Kollsman plant in Elmhurst, N. Y.

COMMISSIONER LELAND OLDS, of New York, has been elected Chairman of the Federal Power Commission. His election is for the remainder of his term of office, which extends to June 22, 1944. In the chairmanship he succeeds Commissioner Clyde L. Seavey, of California, who has been head of the Commission since October 1, 1937, when Chairman Frank R. McNinch was transferred to the Federal Communications Commission.

GEORGE W. PLAISTED, vice president of The Austin Co. in charge of West Coast operations for the past seven years, has been named vice president and general sales manager of the company with headquarters at Cleveland. Mr. Plaisted, a graduate of Worcester Polytechnic Institute, joined the Austin staff in 1916 as a structural and reinforced concrete designer at the Philadelphia office under George A. Bryant, Jr., now executive vice president, serving later as structural engineer and district estimator. He served in the U. S. Navy during the World War and as a public works officer until his return to The Austin Company in 1922, when he became district manager of the Northwest District with headquarters at Seattle and subsequently was appointed Regional Vice President and later Vice President.

ELECTION of Arthur Nutt, vice-president for engineering of Wright Aeronautical Corp., Paterson, N. J., as 1940 president of the Society of Automotive Engineers was announced on Jan. 16 at the business session of the Society's 1940 Annual Meeting in Detroit. He succeeds William J. Davidson, General Motors Corp. Mr. Davidson continues as a member of the SAE Council, as does Harry T. Woolson, executive engineer, Chrysler Corp., who was president of the Society in 1937.

Lincoln Foundation Announces Award Program

STUDIES resulting in speeding the benefits of industrial progress by improving designs, manufacture, fabrication, construction and maintenance of all types of machines, building, structures and products will be the subject for awards to the amount of $200,000, according to an announcement made by The James F. Lincoln Arc Welding Foundation, Cleveland, O.

With a view to creating large-scale benefits, studies will concern machines, products and structures of all types, including: automobiles, trucks, buses, airplanes, locomotives, freight and passenger cars, street cars, ships and boats of all types, buildings, bridges, houses, furniture, heating and air conditioning equipment, electric refrigerators, farming machinery, road-building equipment, as well as industrial machines and products of every conceivable kind.

Awards totaling 458 in number range from $13,700 to $100, and embracing 12 classifications and 46 divisions into which the industrial field has been divided for purposes of participation.

Participation in the Progress Program is open to everyone who plays any part in actually bringing about progress in the executive, design, fabrication, manufacture, construction or maintenance phase of industrial product or structure development. Studies must report progress which can be attributed to application of the electric arc process of welding within the 2½-year period, January 1, 1940, to June 1, 1942. Dedicated to general industrial progress, through scientific interest in and study of arc welding, this $200,000 Award to stimulate widespread study should be productive of far-reaching benefits.

Northwestern University Technological Institute

ARCHITECT'S sketch of the Northwestern University Technological Institute, grounds for which will be broken on the University's Evanston (Ill.) Campus in January, 1940. Courses will be arranged on a 5 yr. basis and follow the co-operative plan, under which students will spend their second, third and fourth years in alternate quarters of class work and field jobs in cooperating industries. While this plan has been tried successfully in many parts of the country, this is the first time that it has been instituted on a comprehensive scale in the Chicago industrial area. The new building, costing nearly $5,000,000, will contain approxmateliy 5½ million cubic feet and in addition to the engineering department and library will house the chemistry and physics departments of the university.

Edwin W. Allen

EDWIN W. ALLEN, vice president of General Electric since 1926, died at noon, January 1 in Johns Hopkins hospital, Baltimore, where he had been under treatment two months following an operation.

Mr. Allen, a native of Virginia, was born at Millview, near Buchanan, Va., on November 8, 1879, the son of Captain Robert E. and Anna L. Allen. He was graduated from Virginia Polytechnic Institute in 1900 and entered the employ of the General Electric Company as a student engineer the following year. He was located in Schenectady until 1911 when he was appointed engineer of the central district, with headquarters in Chicago. He remained in Chicago, except for war service, until 1924 when he was named manager of the engineering department and transferred back to Schenectady. Two years later Mr. Allen was elected a vice president.

Air-Conditioning System to Operate As a Public Utility

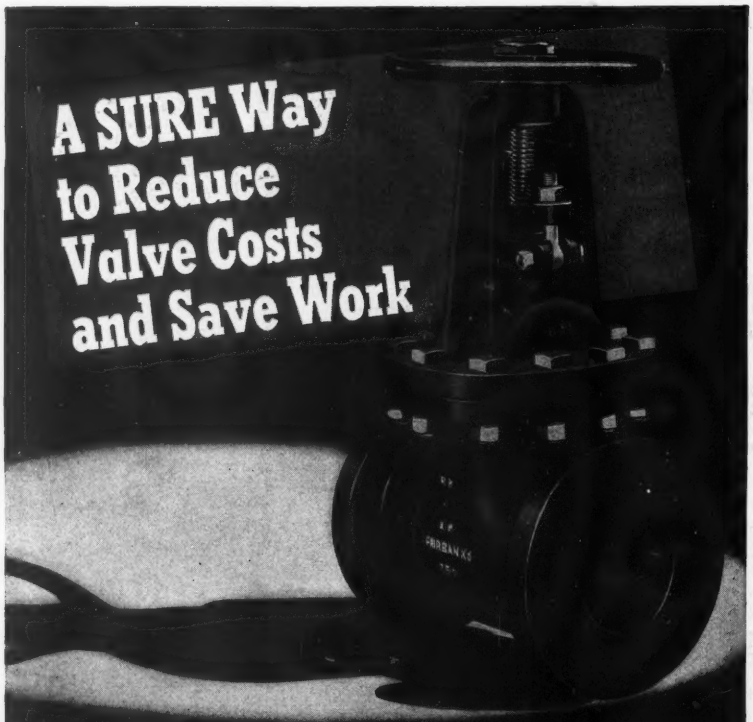
P. E. NICHOLS, JR., Galveston, Tex., and associates are organizing a company to install and operate a local air-conditioning system as a public utility enterprise, said to be the first of its character in the country. The City Council has granted a 50-year franchise to the new organization, to operate in the downtown business area, where the system will serve different retail and commercial buildings and establishments. Project will include a central steam-generating station, where a vacuum jet cooler installation will be made and auxiliary equipment provided for sending cold water from the plant through underground mains, circulating through air-conditioning units located in buildings securing service, with return water system to station for re-cooling.

Ohio Edison Company Plans 1940 Expansion to Cost About $6,550,000

OHIO EDISON CO., Springfield, Ohio, is arranging appropriation of about $6,550,000 for expansion, improvements and modernization in plants and system during 1940, representing the largest de-

Double Gland Asbestos Packed Cock
Pioneered by Reading-Pratt & Cady
Top gland holds plug to seat at pre-determined pressure. Second gland separately controlled to compress the packing. Thus, perfect seal is obtained without binding at all temperatures . . . The U-Grooves of asbestos minimize friction, give tight seal and provide cushion to absorb expansion differential between plug and body.
A COCK THAT BOTH ENGINEERS AND PLANT MEN WILL O.K.
The ease with which this Reading-Pratt & Cady Asbestos Packed Cock operates is, possibly, the chief reason that makes it so desirable . . . Because separate glands hold the plug to its seat and compress the packing, it operates with half the effort.
It is recommended for boiler blow-off, water column blow-off, between check and boiler and between water column and boiler . . . In the plant, use it wherever liquids carry solids in suspension, for viscous fluids, oils, acids and alkalies—ideal for paper mills; steel mills; packing houses; soap, dye-stuffs, by-products and power plants . . . Get it for spots where globe, angle or gate valves fail or where ground cocks are not satisfactory . . . Write for complete data and application to your service.
READING-PRATT & CADY
READING-PRATT & CADY DIVISION · BRIDGEPORT · CONNECTICUT
AMERICAN CHAIN & CABLE COMPANY, Inc.

A SURE Way to Reduce Valve Costs and Save Work



People are apt to forget that the true cost of valves is their original cost *plus* the cost of maintenance.

If you are using valves that are hard to repair when they leak and which have to be removed from the line to make repairs, switch to Fairbanks *Renewable* Valves. Then worn seat rings or wedges can be renewed by one man in a *few minutes*, without removing the valve from the pipe line, at about 5% of the price of a new valve. Fairbanks Renewable Valves do away with lengthy, costly shut-downs.

A small inexpensive stock of Seat Rings and Wedges will repair a large number of Fairbanks Valves, as the standard, heavy and extra-heavy parts are interchangeable. That eliminates the need of maintaining a large stock of expensive valves.

Fairbanks Valves withstand the most brutal punishment because they are made of special semi-steel alloy which has a tensile strength 5,000 to 10,000 lbs. (or 66⅔%) greater than ordinary cast iron.

Measured by actual cost over years of service, Fairbanks Renewable Valves yield the greatest return on your investment.

Write for catalog No. 21 and name of our nearest distributor.

THE FAIRBANKS CO.
397 Lafayette St., New York, N.Y.
Boston • Pittsburgh
Distributors in Principal Cities
Factories: Binghamton, N. Y. • Rome, Ga.

To put in a new ring, simply place it in the valve body so the lugs on ring fit into recesses in valve. A short turn locks it in place.

Fairbanks Renewable Iron Valves

velopment of company since 1930 and exceeding expenditures for similar purpose in 1939 by approximately $3,400,000. Of total fund noted, approximately $2,700,000 will be used for extensions in steam-electric generating station of company at Toronto, Ohio, on Ohio river, where a new 35,000-kw. turbine-generating unit and accessories, highpressure boilers and other equipment will be installed, increasing rating of plant from 140,000 to 175,000-kw. This project will be pushed to completion by the fall of the year, when additional power supply will be required in the Akron and Youngstown, Ohio, districts, furnished by this plant, a considerable block of the increased load being represented by new industrial plants now being located in these areas. In the Akron division, the company will expend about $2,000,000 during the year, and in the Youngstown and Springfield divisions, $1,400,000 and about $450,000, respectively, the work to include new transmission and distributing lines, power substation expansion and betterments, and service facilities. Company is a subsidiary of the Commonwealth & Southern Corporation, New York, N. Y.

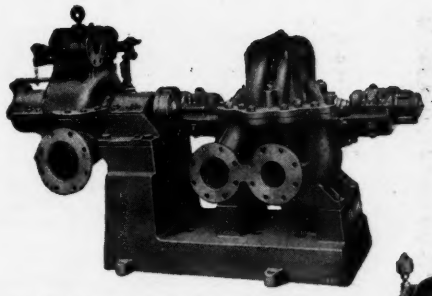
DuQuesne Light Company to Expend $16,000,000

DUQUESNE LIGHT CO., Pittsburgh, Pa., is concluding arrangements for an appropriation of about $16,000,000, to be expended for expansion and improvements in plants and system during the next 24 months. Major part of the program will include an addition to the James H. Reed generating station of company on Brunot Island, with installation of new 80,000-kw. turbine-generator unit, high-pressure boilers and complete auxiliary equipment, with switchyard expansion and new transmission lines. Cost of work is estimated at $7,000,000 of total fund noted. An award for the turbine unit has been made to Westinghouse Electric & Mfg. Co., and contracts for other equipment are scheduled to be made soon. Other features of project will include new transmission and distributing lines, power substations, switching stations and other operating structures, as well as increased service facilities in company territory. Approximately $500,000 of the fund will be used for development of company coal-mining properties at Harwick and Warwick, Pa., where additional equipment will be installed for large increased output.

Public Service Authorizes Budget

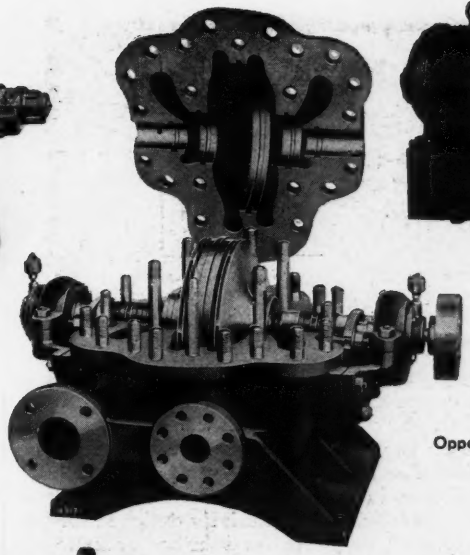
MORE than $17,500,000 has been authorized by Public Service Corporation of New Jersey as a construction budget for 1940. Of this sum, more than $9,000,000 is for the Electric Department of Public Service Electric and Gas Company, which makes a total of more than $53,000,000 allocated to this department since 1937 for the expansion of the company's electric facilities. This sum, a considerable portion of which has already been expended, is considered adequate to provide for any emergency power demand.

At Burlington Generating Station the major construction projects under way is a $12,000,000 extension consisting of a 100,000-kw. turbine-generator and two boilers. This undertaking will provide

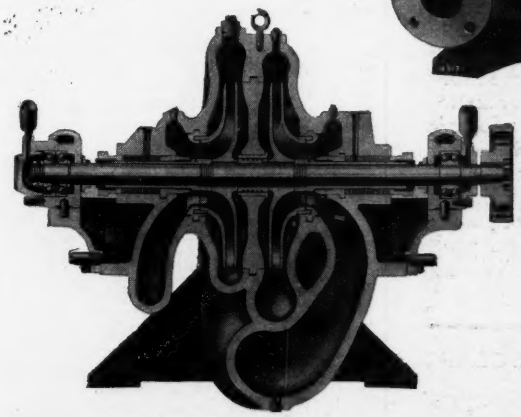


Turbine driven boiler feed pump; 1000 g.p.m. against 807 ft. head at 3500 r.p.m.

Pump with sleeve bearings; 1040 g.p.m. against 259 ft. head at 1750 r.p.m.



Opposed impeller pump with casing cover lifted.



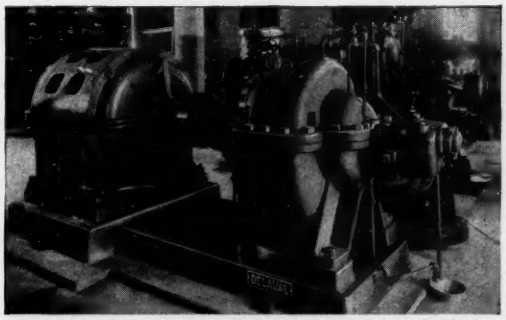
Opposed impeller pump with ball bearings.

DE LAVAL

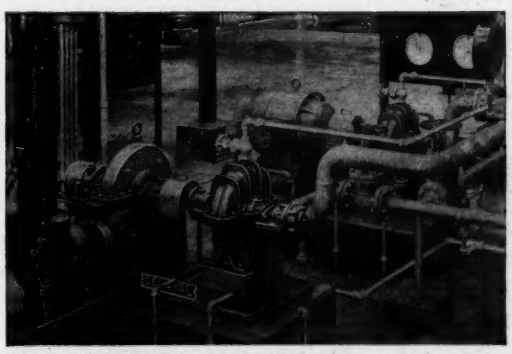
Opposed Impeller

SERIES PUMPS

combine simplicity with high efficiency



Motor driven pump; 2175 g.p.m. against 243 ft. at 1450 r.p.m.



Turbine driven and motor driven pumps handling sodium phenolate solution of 1.15 sp. gr., 46 g.p.m. each against 562 ft. head at 3500 r.p.m.

● Axial balance is obtained by facing the two single suction impellers in opposite directions, which permits of using a short, stiff shaft and reduced clearances, resulting in reduced leakage. Only two pairs of wearing rings to reduce leakage from discharge to suction are needed and leakage between stages is minimized by a labyrinth shaft sleeve, which also protects the shaft from wear, while a bushing protects the diaphragm.

All parts are made to limit gages and parts subject to wear are renewable without replacing main pump parts.

Opposed impeller pumps are built for capacities up to 1500 g.p.m. and for heads up to 750 ft., and higher, depending upon speed and capacity.

We also build single stage, single and double suction pumps for low and moderate heads and multistage, single suction pumps for high heads. State requirements, so that appropriate literature may be sent.

DE LAVAL STEAM TURBINE CO.
TRENTON, NEW JERSEY

Safer Bolt Tensioning with Snap-on TORQOMETER

Equalize stresses and strains this accurate, easy way . . .

For accuracy in . . .

- *Tightening bearings*
- *Adjusting tool set-ups*
- *Setting gaskets on turbines, valves, etc.*
- *Lining up transmissions*
- *Checking power nut runners, bottle cappers, clutches, etc.*

Unequally tightened nuts have jammed many a bearing—endangered men as well as machines. "Play safe" in *your* plant—by checking all nuts with a torque-measuring wrench you *know* is accurate . . . the Snap-on Torqometer. For no matter *how* you hold or pull it, this precision tool always gives *true* readings. That's because it's made with an exclusively designed torque bar that "floats" drag-free on bearings accurate to .0001 inch—imparting "hair-line" precision to a jolt-proof needle that responds to either clockwise or counter-clockwise handle movement, reading either to or from zero, and pre-setting to any dial position. Six models cover complete torque-range from 12½ to 1500 foot pounds. Write for catalog and full information.

SNAP-ON TOOLS CORPORATION
Dep't. PPE-2
Kenosha, Wisconsin

If You Have a Problem

or if you need information on the construction, use or maintenance of any kind of power equipment, the editorial staff of POWER PLANT ENGINEERING will be glad to help you find a solution or get the desired information. Please give as complete details as possible as to what you want so that the editors may have a clear understanding of your wishes.

Write Reader Service Department,
POWER PLANT ENGINEERING.

• •

increased generating capacity sufficient to meet any likely business upturn in the company's territory throughout the state. The Burlington Station is tied in with the company's Kearny, Essex and Marion plants. Ultimately about 500 men will be employed on this work.

A 50,000-kw. turbine generator is being built for Marion Generating Station in Jersey City. This unit will cost approximately $7,500,000 and will furnish work for another 500 men.

Major items in the 1940 Electric Department's budget include a switching station near Camden and high voltage steel tower transmission lines between Camden and Burlington and between Burlington and Trenton. A new substation will be built at Fairview, Hudson Division, and one at Mt. Holly will replace the present one. The high and low tension facilities at Atlantic Avenue Substation, Camden, will be brought up to full efficiency.

More than $1,000,000 will be expended for continuance of the company's policy of placing electric transmission lines underground on main business streets and on heavy traffic arteries where overhead lines become congested.

A new building for the testing laboratory at Irvington is contemplated. This will cost approximately $400,000.

In addition to these expenditures, many improvements have been made in other electrical layouts at generating stations, switching stations and substations.

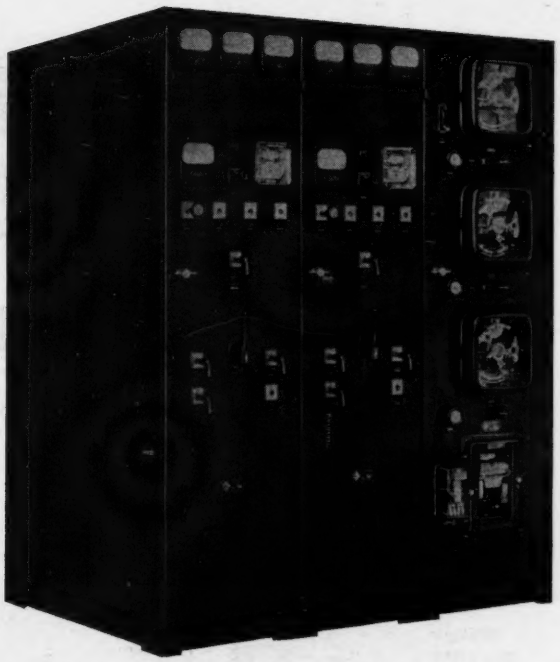
Improvements contemplated by the Gas Department in 1940 include further steps in a comprehensive plant to provide an increased gas supply for rapidly growing Bergen County. Both production and gas transmission facilities will be materially expanded during the coming year.

Work to Begin on Buford-Trenton Irrigation-Pumping Project

THE BUREAU OF RECLAMATION, Denver, Colo., has plans under way for an irrigation and pumping project in the Western part of North Dakota, officially known as the Buford-Trenton Irrigation Project, located in the vicinity of the municipalities of such names in Williams County. An appropriation of $1,500,000 has been arranged for the development, to be furnished jointly from funds of the Department of the Interior and Department of Agriculture. A large pumping plant will be built on the Missouri River in Williams County, near the Montana State line; this station will be electrically-operated, with power to be secured from Fort Peck, Mont., where facilities will be installed at the Government-owned dam, in course of construction for some months past. Transmission line connection will be made with pumping station either with use of part of present power system leading from Fort Peck, or construction of an entirely new line, still to be determined. Project will include about 15 miles of main canals for irrigation system, as well as 6 miles of laterals and a complete drainage system.

This is the first of the Northern Great Plains "relief" irrigation projects recommended for construction by the Northern Great Plains Committee for the rehabilitation of this part of the country. The National Resources Planning Board will assist in the planning and coordination of the work.

ALLIS-CHALMERS VOLTAGE REGULATOR *Pays* FOR ITSELF IN SIX MONTHS!



ALLIS-CHALMERS ROCKING CONTACT GENERATOR
Voltage Regulators also save on installation costs. Only two simple adjustments are required . . . and the neat-appearing regulator takes very little space on your switchboard.

Allis-Chalmers Rocking Contact Regulator Cuts Maintenance Costs . . . Saves $200 on Repairs Alone! Find Out How You Can Beat Production Shutdowns . . . Cut Operating Costs . . . with this Modern, High-Speed Generator Voltage Regulator!

The big crushing rolls are at a dead stop. Men are laboring to clear them. It's dirty, back-breaking work . . . and production is at a standstill.

That was a frequent scene in the plant of one of the world's largest limestone processors when they depended on their former generator voltage regulator. The voltage would drop when the rolls became heavily loaded, and invariably the hopper would be loaded when this occurred.

And the old regulator ran up repair bills, too . . . over $200 per year! But that amount was insignificant when compared to the lost production hours . . . the cost of clearing the crushing rolls.

Then they installed an Allis-Chalmers Rocking Contact Regulator! Former delays through motor kickouts caused by low voltage on the system were eliminated! Maintenance costs were cut to nothing . . . the regulator actually paid for itself in six months!

Slash Your Maintenance Costs!

That's the kind of job these quick-acting, maintenance-free regulators are doing in plants all over the country . . . and that's the job they'll do for you in your plant! Dust and dirt can't get at the bearings and operating mechanism. Friction is no longer a factor . . . thanks to the jewel bearings and rocking contacts. Your maintenance costs are slashed to an absolute minimum!

It doesn't matter what kind of generator you have . . . Allis-Chalmers has a regulator designed to meet your needs! Get in touch with your nearest Allis-Chalmers district office . . . and learn how Allis-Chalmers Rocking Contact Regulators can step-up production in your plant!

A-1192

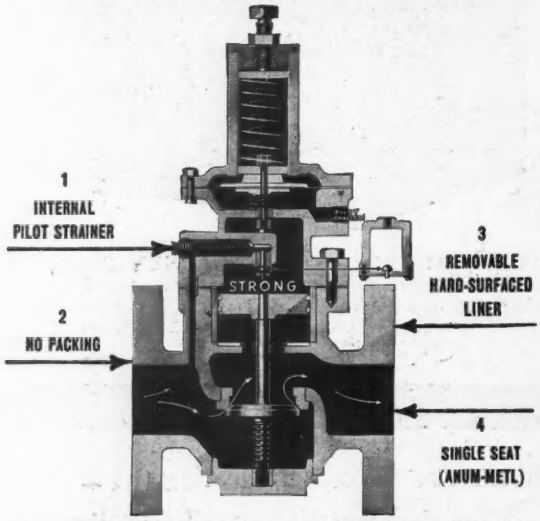
Over 90 Years of Engineering Superiority Work for You When You Specify Allis-Chalmers!

ALLIS-CHALMERS
MILWAUKEE · WISCONSIN

PIPEWRENCH PETE SAYS:

***Now*—You Can Regulate Pressure to a Gnat's Eyelash!**

4 Trouble-Saving Features In STRONG'S Supersensitive Valve!



How STRONG'S Type "C" Valve Works

High (inlet) pressure forces piston down, opening valve and admitting pressure to reduced (outlet) side. When reduced pressure reaches point valve is set to maintain, diaphragm is forced up, closing pilot valve, and shutting off high pressure to piston chamber. As pressure in piston chamber decreases, bottom spring and steam velocity close main valve.

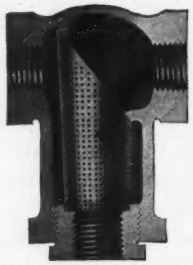
In actual operation, valve automatically adjusts itself to meter the volume of steam, air or gas required to maintain the reduced pressure.

Long, Trouble-Free Life

Because of its simple, sturdy construction, the STRONG Type "C" regulating valve meets the need for accurate, trouble-free pressure regulation.

Write about your pressure reducing problems or for Catalog 154.

QUICK CLEANING STRAINERS



Regular semi-steel, suitable for pressure to 250 lbs. or 400 degrees. Pressure-cleaned by removing bottom plug or opening valve. Install ahead of reducing valves, etc.

The Strong, Carlisle & Hammond Co.
1392 West Third St., Cleveland, O.

10

STRONG
STEAM SPECIALTIES

Midwest Power Conference Program

MANY experts in power engineering will present papers on power production and utilization at the annual Midwest Power Conference to be held in Chicago, April 9 and 10, in the Palmer House, according to the preliminary program announced by Stanton E. Winston, director of the Conference. The conference sponsored by Armour Institute of Technology, is conducted each year in cooperation with seven middle western universities and colleges and several local and national technical societies.

The several mid-western colleges cooperating with Armour Institute in the sponsoring of the Midwest Power Conference are: Iowa State College, Michigan State College, Purdue University, and the State University of Iowa.

"This is the third consecutive year that the conference will be held under the auspices of Armour Institute of Technology," said Professor Winston. "The educational institutions and the industrial representatives have accepted the responsibility for the Midwest Power Conference because of the evident public service that can be rendered. Only at a centralized conference such as this, can all of the technical and social phases of power production, distribution, and utilization be discussed."

The purpose of the Power Conference has been established as that of offering an opportunity for all persons interested in power production, transmission or consumption to meet together annually for the study of mutual problems free from the restrictions of required memberships in technical or social organizations.

The program for the conference includes some twenty-five power phases to be discussed by leading authorities from educational and industrial fields all over the country, and will place special emphasis on steam, Diesel, electric, and hydraulic power. In each of these fields, papers will be presented which will discuss the best modern practice, while other papers will venture into the picture of the future as indicated in the investigations of our great research laboratories. Addresses and papers now definitely scheduled are:

Address of Welcome, Loran D. Gayton, City Engineer, Chicago, Ill.; Power Fallacies, Philip W. Swain, Editor of Power; Maintaining the Optimism in Steam Generator Efficiency, Parker A. Moe, Superintendent of Power, Milwaukee Works, International Harvester Co.; Protection of High Voltage Lines, Philip Sporn, Vice President, In Charge of Engineering, American Gas and Electric Service Corporation, New York; Paper Mill Power, Grover Keeth, Marathon Paper Mills Co., Rothschild, Wis.; Power for the Refinery, R. L. Meyer, Superintendent of Utilities, Whiting Refinery, Standard Oil Co.; Stratification of Gases in Coal-fired Furnaces, John M. Drabelle, Consulting Engineer, Iowa Electric Light and Power Co., Cedar Rapids, Iowa; Pulverized Coal,

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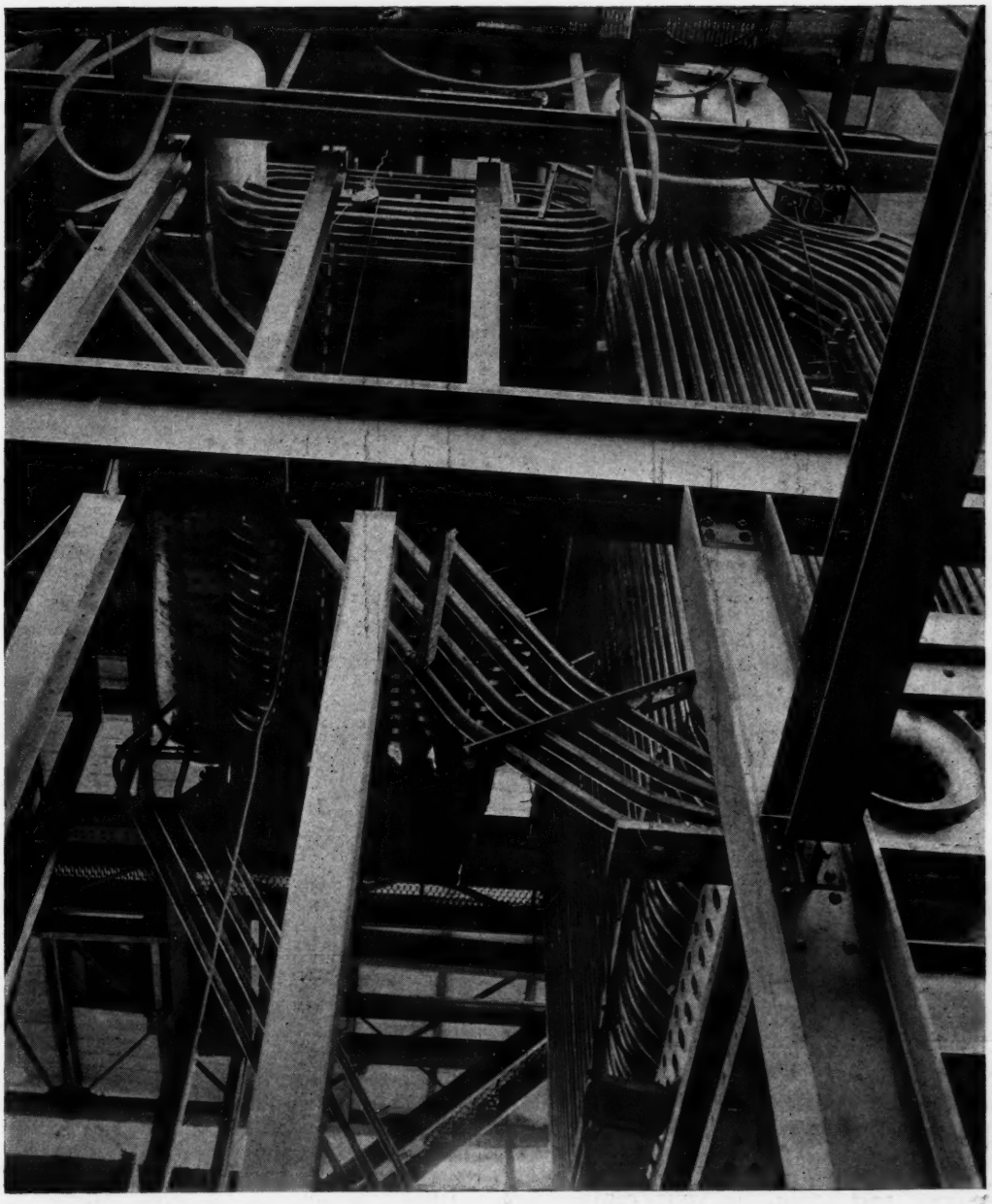

Boilers for Pulverized Anthracite

Low cost fuel—anthracite fines—is being used by the operator of this steam generator. The unit develops 150,000 lb. of steam per hour at 725 lb. pressure and 750 deg. F. final temperature. It is simple, efficient and inexpensive to operate.

The preparation of anthracite for firing in pulverized form is an engineering accomplishment of Foster Wheeler and is backed by five years of successful operation in other boilers.

FOSTER WHEELER CORPORATION
165 Broadway
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FOSTER WHEELER

Easy to take down...

because* DARTS *have Matched Seats

Dart users get the breaks when piping is changed. Darts assure "free breakage", come apart easily because they have two *ground* bronze seats, and do *not* depend on jamming for tightness. Another thing: Darts stay in top condition after *repeated* installation. They assure tight joints again and again, cut your replacement costs to the bone. Give your costs a break. Standardize on Darts.

DART UNIONS

E. M. DART MFG. CO., PROVIDENCE, R. I.
Sales Agents: The Fairbanks Company, New York, and all branches
Canadian Factory: Dart Union Company, Ltd., Toronto, Canada

Martin Frisch, Chief Engineer, Boiler and Pulverizer Division, Foster Wheeler Corp., New York; The Gas-fired Plant and its Problems, E. L. Tindall, Superintendent, Fuel and Combustion, Carnegie-Illinois Steel Corporation, Chicago, Ill.; The Santee-Cooper Hydro Project, L. F. Harza, Harza Engineering Company, Chicago, Ill.; The Hydrological Factors in the Design of a Dam, James S. Bowman, Tennessee Valley Authority, Knoxville, Tenn; and Joint Luncheon with A. I. E. E. Speaker, L. W. W. Morrow, Editorial Director, McGraw Hill Publications, Chicago, Illinois.

Features of 1940 Census

HOW MUCH electric energy was used last year by the 170,000 manufacturers in this country—how much fuel was consumed—how many generators were in use and their rated capacity—how many prime movers and motors were used, and their capacity rating—this is some of the information now being collected for the Sixteenth Decennial Census. This and a wide range of other information of value to power men as measure of operating efficiency will be written into this census—the most comprehensive ever undertaken.

In addition to the Census of Manufacturers, which will cover the power and production operations of manufacturers in 1939, this year's census will include the Censuses of Business, Population, Employment, Wages and Salaries, Agriculture, Drainage and Irrigation, Mines and Quarries, and a Census of Housing to be taken for the first time.

This is the first time since 1929 that the Census of Manufacturers has included complete data on power and fuel. It will make available up-to-date facts and figures keenly awaited by progressive power engineers in every manufacturing plant throughout the nation. It will record the number of kilowatt hours of electric energy generated in the plant, purchased and sold; and comparative figures on each kind of fuel used—the cost and number of tons of coal, barrels of fuel oil and cubic feet of gas, natural, manufactured and mixed. It will also record the number and horsepower rating of motors and prime movers—steam engines and turbines, Diesel, semi-Diesel and other internal combustion engines, hydro-turbines and water wheels. It will include, too, statistics of the capacity rating of standby power equipment.

In addition to this, data never before made available is being collected on expenditures during the year, for new machinery and operating equipment, including motors, cranes, lathes, railroad rolling stock, trucks and other movable equipment; and for plant expansions and alterations.

As usual the Census of Manufactures will cover all manufacturing activities—production and the cost of operations, materials, equipment and labor. It will include in its coverage all producers and users of machinery and supplies employed in the generation,

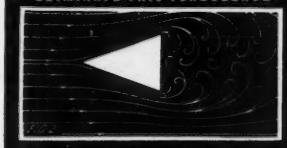
Continued on Page 112

NOW WITH THIS NEW SIMPLE DESIGN

Straight Line
FLOW ELIMINATES TURBULENCE....
...TO GET HIGHEST VALVE CAPACITY
From inlet to outlet, the fluid flows through this valve in a straight line — a streamline — almost as though there was a pipe running through the valve housing for the fluid to flow through. There is no detour around a dividing wall—the direction of flow is not changed at right angles because of a seat wall—also, the flow is not broken up by valve stems, springs, or other parts. The net result is NO TURBULENCE, hence MORE CAPACITY.
CASH STANDARD Streamlined TYPE 1000 PRESSURE REDUCING VALVE
.....GIVES YOU UNUSUAL EFFICIENCY PROVIDED BY THE STRAIGHT LINE FLOW OF AIR-STEAM-WATER-OIL AND OTHER LIQUIDS and GASES THROUGH the VALVE

SHOWING HOW THIS VALVE INCREASES PERFORMANCE RESULTS BY ELIMINATING TURBULENCE . . .

. . . . AND HOW YOU ELIMINATE THIS TURBULENCE



Because of the streamlined flow, you are easily able to meet peak demand and yet hold the pressure constant at the same time. You get correct flow when you need it most. No turbulence is set up and therefore operation is smoother—you have no flow variation—you have constant, dependable action — you experience no spoilage results due to turbulence.

USERS SAY—

More than 125 Streamliners bought in 3 years—because of accuracy—capacity—no trouble—

"We have more than 125 of your 1,000 Streamlined Valves in operation so we should know what we are talking about when we say we are absolutely sure of their accuracy, capacity, and freedom from trouble. After three years' experience with them we have found these Valves so good that we are making all replacements with them on steam, water, air, and gas."—Case No. 167.

Uphold quality of product by constant reduced pressure secured from Streamlined Valves—

"Our conditions are tough, especially in our copper refining, because unless we can hold a steady steam or air pressure it affects the quality of our finished product. Your Streamlined Valve is the best we have ever seen. It also needs less attention or servicing than any other make we have ever used."—Case No. 158.

Used to watch regulator all day long—but have not bothered to go near yours for years—

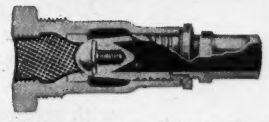
"Our first '1000' Valve was bought about four years ago to replace a ..... regulator on a drying oven. We had to watch the ..... regulator every hour of every day because the pressure roamed all over. The first day we put your Valve in service we had a man watch it all day. Next day we looked at it every hour, but after that we only checked it every other day for awhile. In the last few years we have not bothered to go near it because it is perfect."—Case No. 157.

Streamlined Valves ended all our troubles—

"Our pasteurizing machines had been giving us considerable trouble because of inability to maintain the proper steam pressure. Your '1000' Valves were installed several years ago. This ended all our troubles because they continue to hold the steam pressure right on the nose. We now use them on all pressure reduction lines up to 2½ inches."—Case No. 101.

Never had to be touched—still holding original pressures—

"I keep on buying your Streamlined Valves for the reason that over a period of years they are the only valves in our plant that have never had to be touched since they were installed. They are holding the same pressure today as when they were installed."—Case No. 183.



The high pressure entirely confined to the small inlet chamber.

This feature makes this valve good for initial pressures up to 3,000 lbs. The valve is furnished in sizes from ¼"x¼" up to 2"x2½" inclusive. For delivery pressures below atmosphere, a special diaphragm spring arrangement is used.

Exactly Suited for Your Service Conditions . . .

You may select a CASH STANDARD Streamlined Valve exactly suited for your service conditions. Any combination of metals can be obtained for body, trim, valve seat, and seat ring. Handwheels, for quick pressure adjustment, also available.

30-Day FREE TRIAL Offer

Write for details on this special offer made to give you an opportunity to find new ways to save money.

Send for Bulletin 1000

YOU GET CAPACITY and CLOSE DELIVERY CONTROL *WITH MINIMUM* MECHANISM

Because of this simple, rugged construction, with fewest possible working parts, no close fits, no small ports or passages, and no complicated mechanism, you have no failures—you get longer service—your dollars buy you more in production results.

There is only one vital moving part — the seat piston which is opened in a positive manner by the force of the initial pressure and closed in an equally positive manner by the force exerted by the delivery pressure on the diaphragm. This simple construction of this valve handles surprisingly dirty and heavy fluids without clogging.

The CASH STANDARD Valve stays on the job —you have decreased attention costs, you get many important savings, such as the elimination of the costs for tearing valve down, cleaning, and freeing-up parts.

When this Streamlined Valve is controlling hot fluids, the heat is confined to the tubular passage of the working unit—(cylinder, piston, and jet) because there is no flow through the separate control chamber. Thus, trouble from the effect of heat on the diaphragm and its effect (by transfer) on the diaphragm spring is eliminated. There is no piston spring, or any other spring exposed to the fluid under control, which further solves heat and chemical reaction problems.

After long use you need not send this valve back to the factory for repairs. All you do is order inexpensive replacement parts and install them yourself right in your own plant. However, your first cost will be your only cost for a long time.

A. W. CASH COMPANY
DECATUR, ILLINOIS

CASH STANDARD
CONTROLS . . VALVES

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What you will find in this handy manual:

40 pages of helpful suggestions, with 160 diagrams and simple, concise instructions on time-saving, labor-saving and money-saving methods of sealing cracks and tightening loose parts of boilers, engines, condensers, pumps, heaters, tanks, valves, etc. — making up screwed and flanged joints, and stopping leaks at existing joints and at bolts, rivets, etc.—making walls, floors, tank interiors, etc., water-proof and oil-proof—anchoring machinery to foundations or metal fixtures to metal, masonry or wood —filling up worn or corroded spots on machinery and surface blemishes on castings—and many other similar jobs around the plant.

The advice in this handbook represents the cumulative experience of thousands of engineers in making speedy, effective, and low-cost repairs that have resulted in important savings. It's yours for the asking, together with the protractor, if you fill out and send the coupon.

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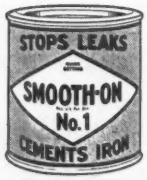

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Since 1895

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utilization and transmission of power. There will be separate tabulations of the number and the pay of those engaged in manufacturing—managers, superintendents and other supervisory employees, including technical and professional men; those on repair and construction work; those who devote their time to selling, advertising or distribution; clerks, bookkeepers and stenographers; and wage earners.

This census will also cover all construction activities last year—residential and other building, heavy and highway construction. Under heavy construction will be included all power plant and hydro-electric projects, transmission lines, pipe lines, aqueduct, dams, sewers and water mains. The new Housing Census will show the electrical facilities of 35,000,000 homes and give exact figures on the number of radios installed in these homes.

The same law which requires reporting to the Census Bureau protects those giving the answers against disclosure of individual returns. All questionnaires used in taking the Census bear the following printed assurance:

"Your report is required by Act of Congress. This Act makes it unlawful for the Bureau to disclose any facts, including names and identity, from your census reports. Only sworn census employees will see your statement. Data collected will be used solely for preparing statistical information concerning the Nation's population, resources and business activities. Your census reports cannot be used for purposes of taxation, regulation or investigation."

Mercury Turbine Increases Plant Capacity

SPEAKING before the combined engineering societies of Schenectady, A. R. Smith, managing engineer of General Electric's turbine division, stated that 12 million kilowatts can be added to the nation's electric power output by "topping" existing units with steam turbines. Then another 11½ million kilowatts can be obtained by superposing with mercury turbines.

"With the usual 1200 lb. 900 deg. F. superposed steam plant, there could be superposed over existing plants of lower steam pressures about 12 million kilowatts of capacity. After this is done further superposition is not possible without resorting to very much higher steam pressures or more complications in the steam cycle, and neither one nor both will add sufficient capacity to justify the enormous expense involved.

"On the other hand, 125 lb. mercury vapor units can be superposed over the already 1200 lb. superposed or 1200 lb. regular units, and there is a potential capacity for this of 11½ million kilowatts. The combination of these two methods will result in a total increased capacity of 23½ million kilowatts."

Recent improvements have enhanced the reliability of the mercury vapor plant, according to Mr. Smith.

Continued on Page 114

You could Operate this Boiler Plant from an *Easy Chair...*

HAGAN AUTOMATIC COMBUSTION CONTROL in the Springdale plant of the West Penn Power Co. This plant is not only the largest but the most efficient of the system.

It's that Simple with HAGAN AUTOMATIC COMBUSTION CONTROL

THE three, 1250 pound per square inch boilers controlled by this Hagan equipment have a capacity of 1,725,000 pounds of steam per hour—yet, in operation, they literally control themselves. When increased loads demand more steam, Hagan Combustion Control automatically changes the fuel and air controls to accommodate the load and maintain highest efficiency at all times.

Automatic combustion control was pioneered by Hagan and has been applied to all sizes and types of boilers. Our engineers will be glad to help you solve difficult combustion problems with an eye to reducing fuel costs. Just write or call. No obligation.

HAGAN CORPORATION

300 ROSS STREET · PITTSBURGH, PA.

HAGAN *Automatic* COMBUSTION CONTROL

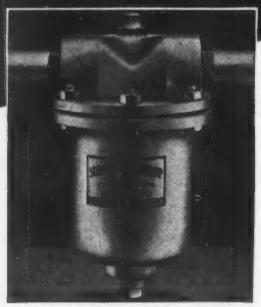
The pioneer . . . and still the leader

102% MORE CAPACITY

75% LESS INSTALLATION TIME

with Anderson

SUPER-SILVERTOP



Anderson Super-Silvertop trap with simplified piping.

Previous model Anderson trap with time-wasting complicated piping.

● Two features give Super-Silvertops 102% more capacity than previous model Anderson traps. First, the guided bucket design permits a larger bucket in the same size case, because the bucket moves only vertically, not from side to side as do buckets in all conventional traps. This larger bucket means that a larger orifice can be opened against the pressure. The valve mechanism of Super-Silvertop pulls the valve well away from the seat to take full advantage of that larger orifice size. Naturally more condensate can flow through an unobstructed orifice than through one that is partly blocked.

75% LESS INSTALLATION TIME. Because there are 75% fewer threaded joints required with the simplified piping of Anderson Super-Silvertops, 75% less installation time is required. This saving in time, which amounts to as much as an hour per trap, is frequent among users of Anderson Super-Silvertop — the inverted bucket trap with simplified piping and guided bucket.

With Super-Silvertop you save on first cost, installation cost and on maintenance. Write today for capacities and prices.

THE V. D. ANDERSON COMPANY
1939 WEST 96TH STREET • CLEVELAND, OHIO

Discovery that a very small percentage of the element titanium maintained in the mercury would prevent steel from dissolving in the mercury has been important. Further, it was found that a two-hundredths of one per cent metal magnesium concentration would keep the titanium active and assist in wetting the steel and obtaining better heat transfer.

A new liquid seal shaft packing is expected to reduce air infiltration to zero on new installation, and a new impact or flash-type sump removes dirt and foreign material from the condensed mercury before it is returned to the boiler drum.

Welded Smoke Stack Costs

By Samuel Barkla

Construction of steel smoke stacks by welding has, because of a number of advantages, become a common practice in the power plant field. Costs, however, have not become so well established throughout the country as construction by riveting. Those of course must be worked out in detail for every locality, and the data given in this article must be considered as a specific example of construction work. This article is from a paper submitted by the author in the $200,000 award program sponsored by the James F. Lincoln Arc Welding Foundation. —Editor.

DESIGNED and built at the Copper Range Company's blacksmith shop, at Painesdale, Michigan, the smoke stack considered here is 75 in. outside diameter by 108 ft. high, and is built of ¼-in. tank steel plate in 6 ft. sections, two plates in each section. Size of plates used is ¼ by 72 by 118 in.

Plates were rolled on a 37½-in. radius, stood on end and tack-welded, then laid on roller stools and the welds completed. The stack was double butt welded throughout, with no vee. The reason for welding on the inside was to insure a good smooth job on the inside.

Twelve guy eyes are attached to the stack, six of these are 12 ft. from the top and six are 50 ft. from the bottom. These guy eyes were put through the stack with a 4 by 4 by ¼-in. reinforcing plate on the inside, all welded. A ½ by 2-in. ring was welded on top and a ½ by 2½-in. ring was welded on the bottom of the stack.

In the stack are 17 straight sections and one bell-shaped section at the bottom, to fit over a 7 ft. diameter base, making a total of 18 sections. The stack was first welded in halves then moved to its location and welded together in one piece, after which it was raised into position by means of a 110-ft. jinpole.

COST

22,565 lb. of ¼ in. tank steel plate at 3½c	$ 789.77
118 lb. of mild steel at 3½c	4.13
330 lb. of electrodes at 9½c	31.35
23,013 lb. Total cost of materials	$ 825.25

LABOR

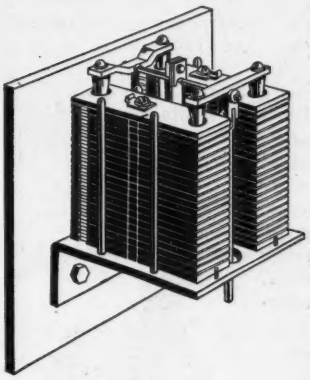
Unloading and assembling plate 154 hr. at 47c	72.38
Rolling 144 hr. at 47c	67.68
Staging and welding 272 hr. at 47c	127.84
Total cost of stack (not erected)	$1093.15
Cost per pound of stack	$0.0475

Continued on Page 116

NEW SMALL DIACTOR REGULATOR

For $70 List

Brings dependable voltage regulation to the small machine



All Diactor regulators have this type of fast, smooth-action rheostatic element—the only element that provides an infinite number of smooth resistance steps from practically zero to the maximum.

YES, there's a new small Diactor regulator in this outstanding line of General Electric generator-voltage regulators. It's the new Type GDA-29 for use with a-c generators, 31.3 kva and smaller, having self-excited exciters. Now you can equip machines in this size class with Diactor regulators built specially to do this job—at a cost that takes dependable voltage regulation for these small generators out of the luxury class.

Is a Full-fledged Regulator

This small regulator is the same as other Diactor regulator models in every way except size. It has the same quick-action, wide-range rheostatic element—the only element that provides an infinite number of smooth resistance steps from practically zero to the maximum. And the regulation curve obtained with it is correspondingly smooth. The enclosing case prevents the entrance of dust and dirt and gives the regulator a smooth, streamline appearance.

A Complete Line—Six Ratings

G-E Diactor regulators are available in six different ratings—for generators rated 18,750 kva at 3600 rpm, and smaller machines at correspondingly lower speeds. This complete line makes it easy for you to select regulators in correct ratings to meet your needs. A specialist in the nearest General Electric office can give you detailed information. Or use the coupon below to obtain Bulletin GEA-2022C. General Electric, Schenectady, N. Y.

General Electric Co., Dept. K-630-17
Schenectady, N. Y.

Please send me a complete description of the new line of Diactor generator-voltage regulators. (GEA-2022C)

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Company.....

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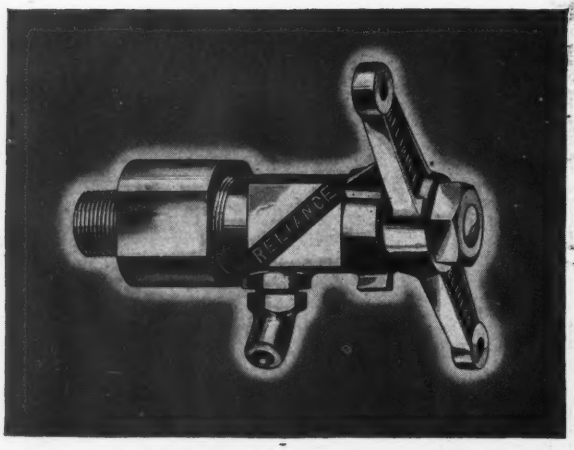

Reliance Steel Gage Cocks

give long profitable service without trouble or expense

When you make wise provision against leaky gage cocks with Reliance Forged Steel Cocks you avoid annoyance, wasted time and expense. Steam proof, even up to 2000 pounds. Reliance Gage Cocks *shut tight*—literally end all gage cock troubles.

Shank and body of forged steel form a sturdy housing for the quick-acting triple-thread stem of monel metal. Stainless steel seat and disc finished to glass-hard surfaces by Reliance's special process.

Get rid of fizzing gage cocks that spoil your otherwise efficient plant. Write today for full information.

The Reliance Gauge Column Co.
5902 Carnegie Avenue • Cleveland, Ohio

Reliance
Boiler Safety Devices since 1884

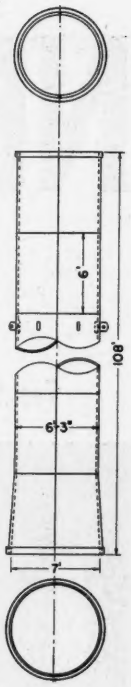

Fig. 1. Stack in position at the Isle Royale stamp mill
Fig. 2. Dimensions of welded steel stack

Although we have built quite a number of smoke stacks all others have been riveted stacks so this is the first all-welded stack we have built and is also the first all-welded stack built in the Copper Country of Michigan. Our records show the welded stack cost 25 per cent less than riveted construction. In welding the stack we arranged to have the longitudinal seams in one straight line and the result is a nice looking job.

M. I. T. To Study Use of Sun's Heat

UTILIZATION of solar radiation has reached the point where an experimental house has been designed to trap the sun's heat falling on the roof and store it in the basement for future use and being made the subject for research at the Massachusetts Institute of Technology.

Investigators will study various uses of solar heat, including winter house heating, summer air conditioning, and power generation. In the basement of the especially designed laboratory house is a large well-insulated water storage tank which will be used for ironing out the fluctuations in heat collected from a source so variable as the sun. The building's heating system consists of a method of forced air circulation so arranged that the flow of air can be either over the hot tank surface or through the coils of a refrigeration system to be installed later. This refrigeration system, operating on an absorption principle, will utilize sunlight as its heat source.

While the Technology engineers are well aware that the amount of solar heat in New England would make domestic heating by solar radiation uneconomical in comparison with other sources of heat, there is

Continued on Page 120

Department Store Buyer
FINDS BARGAIN IN BASEMENT

HERE'S a bargain that customers of Lord & Taylor, prominent New York department store, will never see. But to engineers, it tells a real story of low-cost, trouble-free valve performance.

The store's 25 hydraulic elevators carry 60,000 customers up and down during a peak business day of the year. Valves on the suction end of the pump are under constant pressure, which fluctuates from 75 to 175 lbs. with each trip of the elevators.

The 8" Jenkins Iron Body Gate Valve, shown here, was installed in 1913—has served ever since—with no maintenance of any kind! And it's still going strong.

Now, note the "cost-per-year" figures in the box—and you see why engineers who check the *true* cost of valves before buying for replacement say "Jenkins Iron Valves are my best buy."

JENKINS BROS., 80 White St., New York, N.Y.; Bridgeport, Conn.; Boston; Atlanta, Ga.; Philadelphia, Pa.; Chicago, Ill.; Houston, Texas Montreal, Canada London, England

TRY THE COST-PER-YEAR TEST
on this Jenkins Iron Valve
(Fig. 651)

Initial Cost . . .	$60.75
+	
Maintenance . . .	0.00
÷	
Years of Service . . .	27
=	
COST PER YEAR .	*$2.35*

and it's still going strong!

IN VALVES *Jenkins* GIVES YOU EVERYTHING

Are You Equipped to Hold Your Job?—to Get a New One?

The men who are keeping their jobs today—who are not feeling the whip of competition—are those who have kept one jump ahead of their jobs. They are the men who are equipped with a thorough-going and growing knowledge of the business they are in.

It works in the power plant field as well as in any other. Some men fit themselves to do a little more than their job calls for. They fit themselves to do a little more than the other fellow. They make a steady effort to equip themselves with the best kind of job insurance there is—KNOWLEDGE.

How about you? Do you know how quickly knowledge will pile up—how quickly you will become more valuable—if you spend a few minutes a day, regularly, studying sound books like the McGraw-Hill Library of Power Plant Practice? Do you know how easily it can be managed, paying only a few cents a day, while you use the books? Thousands of men have followed this plan to win advancement or to make their jobs safe. You can too. Read about this Library and our 10 Day Examination Offer. Then send the attached coupon to us today.

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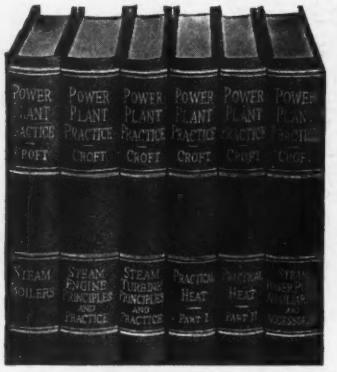

The Library of Power Plant Practice is the standard of the power plant field. It is accurate—it is thorough—it is complete. It is the result of years of experience with power plant problems. The man who has it has the best. The Library covers the whole field—nothing is omitted. The solution of every problem is plainly worded or explained with a clear illustration. The little stickers and the big troublesome problems are all worked out in advance for you. There can be only one result from studying these books a few minutes each day—more money in your pocket.

No books dealing with the work of the power plant man were ever so complete—so authoritative—so practical in text and illustrations as these. The man who puts this set of books into his library can do so knowing that he has the utmost in power plant books—a set that will give him, in language he can understand, all the information he needs in order to get ahead in his work.

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These books are written in everyday easy-to-understand language. They are written to help the man on the job. It is just as if the author were working in the plant by your side and giving you the benefit of his vast knowledge, man to man. There's no bunkum in this Library, nor is it cluttered up with impractical theories. It is a **Power Plant Library** FOR POWER PLANT MEN.

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sufficient sunshine in this region to test the efficiency of heating systems for localities where the climate is less rigorous.

Professor Hottel explained that, although several types of energy collectors, or "heat traps", are to be tried in the Technology research program, first attention is to be given to a shallow, box-like heat collecting device placed in a recess on the roof of the building. The bottom of the box is a thin sheet of metal painted black to absorb the utmost amount of solar energy. Firmly fixed to the under side of the sheet is a series of small thin-walled metal tubes which are heated by contact with the sheet and which in turn heat water circulated through them.

The box has several covers of glass, interspaced with dead air regions, through which nearly all the sunlight can pass, but back through which little heat can escape. The sunlight is converted to heat when it strikes the metal sheet. Beneath the box is a layer of mineral wool to prevent the escape of heat in that direction.

After the water has been warmed in the heat collector, it passes through carefully insulated pipes to the storage tank in the basement. The tank is so thoroughly insulated that it will lose little heat over long periods of time. Depending upon the size of the tank, water can be kept hot from a few weeks to a half a year by this method. To use the heat in the storage tank for heating purposes, a system of forced air circulation is employed in which the air passes through ducts one wall of which is the hot side of the tank.

Part of the research at the Institute will be to study these methods of operation and also to study the most efficient types of paint to use on the collecting devices, the most effective number of glass plates to use over the collector, and the best angle of roof slope to meet the requirements of various types of heaters. The roof on the Institute's sun laboratory slants at an angle of 30 deg. with the ground. The greater the number of glass plates used, the greater the insulation against heat loss, but each additional plate cuts down by about eight per cent the amount of sunlight which may pass through to the absorbing sheet.

This research is one of several important projects planned under the solar energy program and made possible by a gift of nearly $650,000 presented last year by Dr. Godfrey L. Cabot of Boston for research on the utilization of solar radiation for the tasks of man. These studies are being carried on under the direction of a committee of which Prof. Hoyt C. Hottel of the Institute's department of chemical engineering is chairman.

More fundamental research in connection with the utilization of the sun's energy will be concerned with a study of the mysteries of certain photochemical, photoelectric, and thermoelectric phenomena. Whether or not sunlight can be converted directly into electricity will be determined by a study of the mechanisms involved in photo-cells, photogalvanic cells, and thermopiles. These devices have long been known capable of producing electrical energy from radiant energy, but their efficiencies have never been great enough to make them practical.

A HANDFUL OF DUST What does it mean to you? It *can* mean the difference between profit and loss in your business. Unless dust is kept under control by modern dust collection equipment, your business may suffer from one or more of these serious losses—

RECLAMATION LOSSES—*due to waste of valuable dusts, as in ore refineries, cement kilns, foundry shake-down rooms, etc.*

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Only Buell Cyclones have a Dust Pocket

"DUST COLLECTION" and "FLY ASH CONTROL"
are two interesting booklets we shall be glad to mail upon request . . .

16 CEDAR STREET, NEW YORK

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buell DUST COLLECTORS

Wherever located, you will be quickly served through sales offices of either BUELL ENGINEERING CO., or B. F. STURTEVANT CO.

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Recent bulletins and catalogs on power plant equipment listed for your convenience in securing specific information. Power Plant Engineering will be glad to procure for you any free literature that you desire.

Meters and Instruments

Electrical Measuring Instruments for Research, Teaching and Testing—Catalog E, containing 66-pp., lists the entire Leeds & Northrup line of instruments for research and for routine testing in laboratory, plant and field. Every standard item is briefly described, and most of the principal ones are illustrated. For more complete descriptions the reader is referred to more detailed publications. Many instrument users will find this condensed catalog a useful guide. Leeds & Northrup Co.

Industrial Metering is the title of a new 16-pp. bulletin B-704 which has been compiled to point the many and diverse applications for meters in industry. The company's complete line of meters is briefly described, giving a reference to another bulletin which contains a detailed description of the specific equipment. Pittsburgh Equitable Meter Co.

Meters for Steam, Liquids and Gas—A 47-pp. illustrated bulletin No. 200-4 covers the use of flow meters; discussions of flow problems encountered in various industries; and data on universal flow meters, pressure compensating meters, bell-type meters, wide-range meter settings, high pressure meters, square root intergrators, indicating flow meters and meter accessories. The Foxboro Co.

Electrical Equipment

Switchgear—Bulletin 3911, a new 5 page illustrated booklet, describing the use of I-T-E switchgear at Inland Steel's new 44-in. hot strip mill. An interesting description of the many new electrical features installed by this company. I-T-E Circuit Breaker Co.

Small Motor Gears—Motor Data Sheet M-61 describes and illustrates the line of open gear reductions for the type YAr size Motors, ranging from 0.005 to 0.26 hp. Three gear ratios are provided for output shaft speeds of 80, 54 and 11 r.p.m. Barber-Coleman Company.

Electrical Equipment—Power Factor and Its Improvement is the title of Bulletin GEA-3225 which gives a complete treatise on power factor and describes the G.E. Pyranol capacitors. Bulletin GEA-1724B entitled Synchronous Motor Control gives a complete description of the new SCI Relay. General Electric Co.

Welder — Bulletin 336 gives a description of the Engine-driven 200-Ampere Shield Arc junior welder. The Lincoln Electric Co.

Fluorescent Lighting — Two new folders illustrate, describe and give specifications for the Miralume HF-100 and the Miralume HF-200. The Hygrade Sylvania Corp.

Mercury Arc Rectifier — Bulletin No. B-6064 describes and illustrates the standard multi-anode rectifiers and provides information on the recently announced Excitron single-anode rectifiers particularly suited for the lower voltage applications from 250 to 300. Allis-Chalmers Mfg. Co.

Switchgear—Catalog 8-b illustrates and describes a new moderate duty, vertical lift, metal clad switchgear. Roller-Smith Company.

Heating and Cooling

Unit Heat—An attractive 16-page circular, full of illustrations and drawings, describes the new built-in-wall type Electromode and the new portable Electromode heaters. The American Foundry Equipment Co.

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Heat Exchangers—Bulletin OH-39-19 is an 8-pp. catalog in color describing the construction, installation and advantages of spine tube heat exchangers in which a new extended surface construction is utilized to give greater rates of heat transfer between two fluids in commercial design heat exchangers. Foster Wheeler Corp.

Spray Nozzles—Bulletin 250 shows the various types and sizes of nozzles for water cooling and all industrial applications. Comprehensive data as affecting capacity and spray coverage is also included in the bulletin. Binks Mfg. Co.

Refrigerating Units—Worthington steam-jet vacuum refrigerating units are described and illustrated in an 8-pp. bulletin, W-207-B1. These units are built in a capacity rating ranging from 8 to 780 tons. Worthington Pump & Machinery Corp.

Power Application

Bearings—Catalog L-2 covers a new size listing of Ledaloyl self-lubricating bearings with more than 850 stock sizes available for immediate delivery. In addition to listing these sizes, part numbers, prices, technical and application data is included. Johnson Bronze Co.

Conveying Equipment—Bulletin 109 gives a brief description of the complete line of Robins Conveyor Equipment. Robins Conveying Belt Co.

Farrel Gearflex Couplings—Catalog No. 443 explains the function of a flexible coupling and describes how Farrel Gearflex Couplings compensate for parallel or angular misalinement or a combination of both, illustrating the details of design and construction. It gives the applications, ratings, dimensions and weights of the various types of flexible couplings. Farrel-Birmingham Co., Inc.

Cranes—A new sectional catalog gives a complete description of Whiting Cranes, with detailed information and the specific parts that go to make up this equipment. Whiting Corp.

V-Belt Drive Design—A new 24-pp. catalog section 2180 on fractional-horsepower V-belt design explains the problems of selecting a V-drive using stock belts in terms so understandable that a purchaser or operator without professional engineering training can comprehend them. Conversion of belt numbers and standard fractional horsepower V-belt pulley groove top widths are also given. The B. F. Goodrich Co.

Miscellaneous

Building Maintenance—A 68-pp. booklet of technical information for factory engineers and maintenance men shows how to do hundreds of odd jobs at lower cost with better results. Many ideas that save valuable time and materials are presented. Flexrock Co.

Alloy Tubes—Technical Bulletin No. 12-A., Condensed Technical Data on High-Temperature Steels, contains revised useful information and technical data on B&W Seamless Alloy Tubes and Pipe for High Pressure and High Temperature Services. The Babcock & Wilcox Tube Co.

Diesel Engines—The Alco Diesel for Universal Application is the title of a 16-pp. catalog in color describing construction and showing typical installations of Alco Diesel engines for stationary, marine and locomotive service. American Locomotive Co.

Aerators is the title of Bulletin No. 100 which discusses the purifying functions of aeration and describes and illustrates the various types of aerating equipment available including forced draft, coke tray, MultiCone, spray and cascade types. Useful information is given on the construction, operation and application of each different type. International Filter Co.

Motion Pictures—A new catalog of motion pictures, both sound and silent, which are designed for the use of organized groups such as educational institutions, churches, and social, civic and business clubs. With the exception of a small shipping charge, there is no cost to the borrower of these films. General Electric Co.

Selected Editorials—A 64-page book of Selected Editorials which have been reprinted from Link-Belt News, a monthly publication. These editorials of broad general interest and mostly of a philosophical, inspirational nature, were, in the main, written by prominent authors and first appeared in well-known magazines or newspapers, having later been reprinted in the News by special permission. Link-Belt Co.

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Power Plant Construction News

Ariz., Morenci—Phelps-Dodge Corporation, 40 Wall Street, New York, N. Y., plans power house in connection with new smelting and concentrating plant at copper-mining properties at Morenci. Entire project will comprise a number of large production units, with cost reported in excess of $2,500,000, and will require about 24 months for completion. Company engineering department, 25 Broadway, New York, N. Y., will be in charge.

Calif., Burbank—Lockheed Aircraft Corporation, Empire Avenue and Victory Place, plans installation of electric power equipment in new one-story addition to airplane plant, about 40,000 sq. ft. of floor space, to be used for expansion in assembling division. Erection will begin soon. Entire project will cost over $100,000. John and Donald B. Parkinson, Title Insurance Building, Los Angeles, Calif., are architects.

Conn., Elmwood — Wiremold Co., Hartford, Conn., manufacturer of cables, conduits, etc., plans installation of electric power equipment in new addition to plant at Elmwood. Entire project is reported to cost close to $100,000. Proposed to begin work soon. J. Di Stasio & Co., 136 Liberty Street, New York, N. Y., are engineers.

Fla., Tampa—Tampa Shipbuilding & Engineering Co., plans installation of electric power equipment in connection with expansion and improvements in shipbuilding plant, including construction of new shipway, shops and auxiliary structures. Entire project will cost about $250,000. Financing has been arranged and work will begin soon.

Iowa, Cascade—Town Council has approved plans for immediate construction of new municipal electric power plant. Award for building erection has been let to L. A. Kepp Contracting Co., Rochester, Minn. Cost estimated at $110,000, including equipment, for which awards will be made separately. Young & Stanley, Inc., Muscatine, Iowa, is consulting engineer.

Iowa, Waterloo—Rath Packing Co., Sycamore and Elm Streets, has approved plans for erection of four-story addition to power house at meat-packing plant, 40x60 ft., to be engine room and auxiliary service. Cost reported over $85,000, with equipment. Henschien, Everds & Crombie, 59 East Van Buren Street, Chicago, Ill., are architects and engineers.

Ky., Louisville—Louisville Gas & Electric Co., is arranging budget of about $2,000,000 for expansion and improvements in power plants and system during 1940, including transmission and distributing lines, power substations, switching stations and other operating facilities.

Mass., Chelsea — Panther-Panco Rubber Co., Inc., 31 Highland Street, manufacturer of rubber heels, rubber soles, etc., plans installation of electric power equipment in new one-story mill addition, 110x175 ft., for which superstructure will begin soon. Entire project will cost over $85,000. Isadore Richmond, 248 Boylston Street, Boston, Mass., is architect.

Mich., Watervliet—City Council will have plans completed soon for new municipal power plant, to be constructed and operated jointly with Village Council, Coloma, in immediate vicinity, and Boards of Township Commissioners of Watervliet and Coloma Townships. Proposed to carry out work in spring. Estimates of cost are being made. Ayres, Lewis, Norris & May, Wolverine Building, Ann Arbor, Mich., are consulting engineers.

Minn., St. Paul.—University of Minnesota, Minneapolis, Minn., R. S. Callaway, Administration Building, purchasing agent, will receive bids until Feb. 15 for two boiler units, each with capacity of 30,000 lbs. per hour, for installation in power house at University Farm, St. Paul, including equipment for using pulverized coal, air preheaters, superheaters, forced and induced draft fans, fuel pulverizers, etc. W. F. Holman, first noted address, is supervising engineer, Department of Buildings and Grounds.

Mo., Greenwood — Jackson County Public Water System, District No. 5, care of I. Frank Ropes, Fidelity Building, Kansas City, Mo., attorney and representative, plans installation of pumping plant and 60,000-gal. elevated

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Grey Iron and Special Alloy Castings
Steam Turbines for Mechanical Drive
Steam Turbines for Generator Drives
Water Tube Heating Boilers
Horizontal Tubular Boilers
Scotch Marine Boilers
Water Tube Boilers
Special Turbines
Corliss Engines
Unit Heaters
Gears

steel tank and tower, in connection with new water line. Entire project will cost about $103,000, and bond issue in that amount has been approved. C. M. Kerr, Water Department, City Hall, Kansas City, is engineer.

N. D., Fargo — Northern States Power Co., Minneapolis, Minn., will carry out extensions and improvements in steam-electric generating plant at Fargo during 1940, with installation of additional equipment. Fund of about $90,000 is being arranged for this and other work at Fargo and vicinity.

Ohio, Toledo—Water Department, 561 Erie Street, will receive bids until Feb. 28 for two large electric-operated pumping stations for new Lake Erie water supply system, now in course of construction, consisting of a high-pressure plant in Collins Park, estimated to cost about $800,000, with machinery; and low-pressure station near main intake at Reno Beach, to cost approximately $600,000, with equipment. George N. Schoonmaker is city manager.

Okla., Oklahoma City — Oklahoma Gas & Electric Co., Oklahoma City, has authorized fund of about $1,600,000 for expansion and improvements in 1940, including power plants, transmission and distributing lines, power substations, switching stations and other structures.

Ore., Portland — Portland General Electric Co., has authorized appropriation of about $2,000,000 for expansion and improvements in plants and properties in 1940, including generating stations, power substations and switching stations, transmission and distributing lines, and other operating facilities.

Pa., Bethlehem — Bethlehem Steel Co., South Bethlehem, plans installation of electric power equipment in new one-story addition to mill at New and Second Streets, about 200 by 450 ft. Site has just been acquired and work is scheduled to begin soon. New heat-treating furnaces and auxiliary equipment will be installed. Entire project is reported to cost in excess of $850,000.

Pa., Lancaster—Armstrong Cork Co., Lancaster, plans installation of electric power equipment in new addition to local cork products and linoleum plant. Cost reported close to $500,000. Proposed to carry out work in the spring.

Pa., Marcus Hook — Sun Oil Co., 1608 Walnut Street, Philadelphia, Pa., plans installation of power equipment, pumping machinery, steel tank storage facilities and other equipment in connection with expansion and improvements in oil and gasoline refining plant at Marcus Hook, to include a complete new production unit for large increased capacity. Entire project will cost about $6,500,000. Work will be carried out in 1940.

Tenn., Columbia—Columbia Locker Storage Co., 1107 South Garden Street, Burgess Askew, Jr., general manager, has plans for new one-story cold storage and refrigerating plant, with locker system. Cost reported over $25,000, with equipment.

Texas, Dallas — Dallas Power & Light Co., is arranging fund of about $500,000 for expansion and improvements in 1940, including generating station, power substations, transmission and distributing lines, and other operating facilities.

Texas, San Augustine—City Council has plans nearing completion for expansion and improvements in municipal power plant, including installation of new 300-kw. Diesel engine-generating unit and auxiliary equipment. H. B. Gieb & Co., Mercantile Building, Dallas, Tex., are consulting engineers.

Va., Alexandria — Virginia Public Service Co., 117 South Washington Street, has plans maturing for new steam-electric generating station on Union Street, to be equipped for an initial capacity of about 15,000-kw., including turbine-generator unit and accessories, high-pressure boilers and auxiliary equipment. Project will be carried during 1940 and is estimated to cost about $2,000,000. Equipment contracts will be awarded soon. Gilbert Engineering Co., Reading, Pa., is consulting engineer. New plant will be operated by the Virginia Public Service Generating Co., recently organized subsidiary.

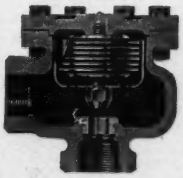
W. Va., Follansbee — Follansbee Brothers Co., Third and Liberty Streets, Pittsburgh, which recently secured Federal Court permission to reorganize, plans installation of electric power equipment in connection with expansion and modernization in steel mill at Follansbee, where company will concentrate production largely in future. Fund of about $1,200,000 is being arranged for program. Capacity of power station at mill will be increased.

Wis., Ladysmith — Peavey Paper Products Co., Ladysmith, plans extensions and improvements in hydroelectric generating station, including installation of new generating units and auxiliary equipment. Cost estimated at $150,000. Proposed to begin work soon. Plant is owned by Lake Superior District Power Co., Ashland, Wis., and operated under lease.

NICHOLSON

Money-Saving

TRAPS



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Burgess Battery Company

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Ingersoll-Rand Co.
Worthington Pump & Machy. Corp.

AIR EJECTORS
Ingersoll-Rand Co.

AIR PREHEATERS
Babcock & Wilcox Company, The
Combustion Engrg. Co., Inc.
Foster Wheeler Corporation

AIR WASHERS
American Blower Corp.

ANTI-FRICTION METAL
Magnolia Metal Co.

ARCHES, BOILER & COMBUSTION
Carborundum Co., The

BAFFLES, BOILER
Engineer Company, The

BEARING METAL
Magnolia Metal Co.

BLOWERS, FAN AND FURNACE
De Laval Steam Turbine Co.
Ingersoll-Rand Co.

BLOWERS, TUBE
Bayer Company, The

BLOWERS, TURBINE
Elliott Company
Moore Steam Turbine Corp.
Terry Steam Turbine Co., The

BOILER BLOW-DOWN SYSTEMS
Cochrane Corporation
Elgin Softener Corporation
Hensey Company
National Aluminate Corp.

BOILER COMPOUNDS
American Sand-Banum Co., Inc.
Dearborn Chemical Company

BOILER FEED WATER PURIFYING APPARATUS
Elgin Softener Corporation
Permutit Co., The

BOILER SETTINGS
Carborundum Co., The
Engineer Company, The

BOILER SETTING CEMENT
Carborundum Co., The

BOILER TUBES
Babcock & Wilcox Tube Co., Inc.
Pittsburgh Steel Company

BOILER WATER TREATMENT
American Sand-Banum Co., Inc.
Buromin Company, The
Dearborn Chemical Company
Elgin Softener Corporation
National Aluminate Corp.
Permutit Co., The

BOILERS, POWER AND HEATING
Babcock & Wilcox Company, The
Combustion Engrg. Co., Inc.
Edge Moor Iron Works, Inc.
Foster Wheeler Corporation
Murray Iron Works Co.
Springfield Boiler Company
Vogt Machine Co., Inc., Henry
Wickes Boiler Co., The

BOOKS
McGraw-Hill Book Co., Inc.

CEMENT, IRON
Smooth-On Mfg. Company

CEMENT, REFRACTORY, ACID PROOF, FURNACE AND HIGH TEMPERATURE
Babcock & Wilcox Company, The
Carborundum Co., The
Kellogg Co., The M. W.

CHAIN WHEELS
Babbitt Steam Specialty Co.

CHEMICALS, WATER TREATING
Betz, W. H. & L. D.
Buromin Company, The
Dearborn Chemical Company
Elgin Softener Corporation
National Aluminate Corp.
Permutit Co., The

CHIMNEYS
American Chimney Corp.

CLEANING COMPOUNDS
Dearborn Chemical Company

CLUTCHES
Cutler-Hammer, Inc.

COAL CRUSHERS
American Pulverizer Co.

COALS, STOKER, GAS SCREEN
Chesapeaks & Ohio Lines
General Coal Company

COAL WEIGHING & MEASURING EQUIPMENT
Richardson Scale Co.

COCKS, AIR AND STEAM
Crane Co.
Dart Mfg. Company, E. M.
Fairbanks Company, The
Lunkenheimer Co., The
Nicholson & Co., W. H.
Williams Valve Co., The D. T.

COLLOIDAL WATER TREATMENT
American Sand-Banum Co., Inc.

COMBUSTION CONTROL SYSTEMS
Askania Regulator Co.
Bailey Meter Company
Cash Company, A. W.
Engineer Company, The
General Regulator Co.
Hagan Corporation
Hays Corporation, The
Republic Flow Meters Co.

COMBUSTION RECORDERS
Brown Instrument Co., The
Hays Corporation, The
Permutit Co., The

COMPOUND, PIPE JOINT
Smooth-On Mfg. Company

CONDENSERS
Allis-Chalmers Mfg. Co.
Elliott Company
Foster Wheeler Corporation
Ingersoll-Rand Co.
Westinghouse Elec. & Mfg. Co.
Worthington Pump & Machy. Corp.

CONDENSER TUBES
Bridgeport Brass Co.

CONTROL EQUIPMENT, ELECTRICAL
General Electric Company

CONTROLLERS, LIQUID LEVEL
Cash Company, A. W.
Northern Equipment Co.

COOLING SYSTEM TREATMENT
American Sand-Banum Co., Inc.

COOLING SYSTEMS, NOZZLES AND PONDS
American Blower Corp.
Foster Wheeler Corporation
Marley Company, The
Yarnall-Waring Company

COPPER PIPING
Bridgeport Brass Co.
Scovill Mfg. Co.

CORROSION PREVENTIVE
American Sand-Banum Co., Inc.

COUPLINGS, FLEXIBLE
American Blower Corp.
Nicholson & Co., W. H.
Terry Steam Turbine Co., The

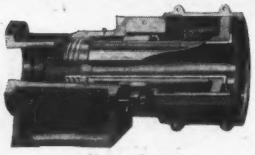
COUPLINGS, UNION
Dart Mfg. Co., E. M.

DEAERATORS AND DEAERATING HEATERS
Cochrane Corporation
Elliott Company
Swartwout Co., The

DECONCENTRATORS
Elgin Softener Corporation

DESUPERHEATERS
Northern Equipment Co.

ADSCO PISTON RING JOINT



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Standard Oil Company of California.

Johnson Wax Company, Racine, Wis.

Arapaho Indian Agency, Concho, Okla.

City of Kingston, Kingston, N. C.

Delco Appliance Corp., Rochester, N. Y.

American Enka Corp., Enka, N. C.

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NORTH TONAWANDA, N.Y.
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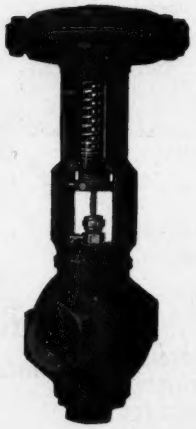
The governor here shown will so control the speed of any steam-driven pump that discharge pressure will be kept constant. The diaphragm is connected to the discharge pipe, carrying oil, ammonia, other liquid, or gas, while the governor valve is installed in the steam line. Any slight variation of discharge pressure on the diaphragm is communicated to the valve, the speed of the pump goes up or down, and discharge pressure returns to normal. Both spring-weighted and lever-weighted types of governor are built. Write for Bulletin 4096.



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WITH THE EDITORS

More Power From Coal

FOR SOME unexplained reason, very few power companies include, in their annual reports to stockholders, an item dealing with the character of the fuel used and the economy secured in the production of power. This seems strange when it is recognized that fuel costs are items of major importance in the operation of a steam power plant, and this item is about the only one in a report that permits comparison of operating efficiency with other companies. The Detroit Edison Co. sets an example in this, as it has done in so many other phases of company operating policies, by publishing in its report a brief but sufficiently complete paragraph on fuel to give stockholders, who are familiar with fuel economy, data by which they may judge the excellent character of the engineering work that is being done by the Detroit company. We quote the entire paragraph:

"Our steam power plants consumed 1,416,622 tons of bituminous coal bought in Kentucky, Virginia and West Virginia, and the equivalent of 66,537 tons in blast furnace and oil refinery gas bought locally. The average price of coal was $3.78 per ton, substantially the same as in 1938. As heretofore, 39 per cent of the cost was the price of coal at the mines and 61 per cent the cost of freighting it to us by rail and lake. Improvement in power plant efficiency made it possible in 1939 to generate each kilowatt-hour of net output with 0.96 lb. of coal. This required an even pound in 1938, and 1.27 lb. in 1929."

This is indeed an enviable record, far surpassing the average utility fuel economy which in 1930 was 1.62 lb. and, in 1938, 1.42 lb. of coal per kilowatt-hour. Even in 1929, Detroit Edison Co.'s fuel economy surpassed considerably the average of today, so it may truthfully be said that the engineering accomplishments of this company are ten years ahead of the average in the field of power utilities.

Due in large measure, no doubt, to the engineering acumen of Alex Dow, president of the company since its incorporation in 1903 and whose retirement from that position has just been announced, this company has placed great emphasis on the engineering phases of company operations. In addition to an efficiently organized engineering department that handles all construction and operation problems, the company has for years maintained a research division that has contributed extremely valuable information in all phases of power generation and utilization, particularly those having to do with combustion, piping, and the use of steam at high temperatures and pressures. The policies of the company dealing with the management of engineering activities is well summarized in one of the closing paragraphs of the report to stockholders which reads:

"Successful conduct of our business requires that we anticipate many coming events, with such foresight as is given to us. New steam turbines must be ordered two years before they are needed. Other construction work must be prepared for at least a year ahead. Our working estimates of revenues and expenses, of cash resources, coal requirements, and materials to be needed, never run less than six months into the future. Sometimes our judgment is good and sometimes it is not. The protection against poor guesses is constant watchfulness, and quick revision when prospects seem to alter."

A little over a generation ago, when power was measured almost exclusively in horsepower, engineers dreamed, almost without hope of accomplishment, of generating one horsepower-hour with one pound of coal. That meant reducing coal consumption to about one-fifth of the best records of the day. With a whole year's record averaging 0.96 lb. of coal per kilowatt-hour of power generated, the dream has considerably more than come into being. The answer, we believe, is company policies that support modern engineering progress.

Honors to Modern Pioneers

IN UNISON with the National Association of Manufacturers, everybody in the power plant field has reason to join in honoring the Modern Pioneers who are on the American frontiers of industry.

It was one hundred and fifty years ago that the American patent system was founded, and with all the faults it possesses and the abuses developed around patent laws, there have been few legislative enactments that have stimulated more improvement in the American standard of living than the patent laws of the United States as they were originally enacted and amended up to their present form.

This anniversary inspired members of the National Association of Manufacturers, who have recognized the social value of employing scientific and engineering knowledge for improving every phase of human living conditions, to honor those in the front line of modern industry whose work has increased employment, provided a new commodity or service, reduced the cost of a product already in use, or improved the quality of a product already in use.

During these days when an endeavor is being made to change radically our patent laws, this public attention given to what progress is being made, almost as a direct result of the protection given to patentees under our present laws, should arouse interest among individuals and organizations that will be helpful in securing an extremely careful and analytical study on the part of Congress when considering modifications of the existing patent laws.